TOTAL MAXIMUM DAILY LOAD (TMDL)

for

E. Coli

in the

Harpeth River Watershed (HUC 05130204)

Cheatham, Davidson, Dickson, Hickman, Rutherford, and Williamson Counties, Tennessee

FINAL

Prepared by:

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
6th Floor L & C Tower
401 Church Street
Nashville, TN 37243-1534

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LIST OF ABBREVIATIONS

ADB	Assessment Database
AFO	Animal Feeding Operation
BMP	Best Management Practices
BST	Bacteria Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CFU	Colony Forming Units
DEM	Digital Elevation Model
DWPC	Division of Water Pollution Control
E. coli	Escherichia coli
EPA	Environmental Protection Agency
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - Fortran
HUC	Hydrologic Unit Code
LA	Load Allocation
LDC	Load Duration Curve
LSPC	Loading Simulation Program in C^{++}
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
MST	Microbial Source Tracking
NHD	National Hydrography Dataset
NMP	Nutrient Management Plan
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCR	Polymerase Chain Reaction
PDFE	Percent of Days Flow Exceeded
PFGE	Pulsed Field Gel Electrophoresis
Rf3	Reach File v.3
RM	River Mile
SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
SWMP	Storm Water Management Program
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TDOT	Tennessee Department of Transportation
TMDL	Total Maximum Daily Load
TWRA	Tennessee Wildlife Resources Agency
USGS	United States Geological Survey
UCF	Unit Conversion Factor
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load for E. coli in Harpeth River Watershed (HUC 05130204)

Impaired Waterbody Information

State: Tennessee
Counties: Cheatham, Davidson, Dickson, Rutherford, and Williamson
Watershed: Harpeth River (HUC 05130204)
Constituents of Concern: E. coli

Impaired Waterbodies Addressed in This Document:

Waterbody ID	Waterbody	Miles Impaired
TN05130204001 – 0600	TRACE CREEK	8.3
TN05130204002 – 2000	JONES CREEK	7.0
TN05130204010 - 0600	ARKANSAS CREEK	5.7
TN05130204013 – 0730	WEST PRONG MURFREES FORK	6.0
TN05130204013 – 0750	MURFREES FORK	18.4
TN05130204013 – 2000	WEST HARPETH RIVER	10.9
TN05130204016 – 1100	FIVE MILE CREEK	14.4
TN05130204016 – 2000	HARPETH RIVER	3.9
TN05130204018 – 0400	KELLEY CREEK	9.3
TN05130204021 - 1000	LITTLE HARPETH RIVER	4.1

Designated Uses:

The designated use classifications for waterbodies in the Harpeth River Watershed include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Portions of Trace Creek, Jones Creek, Harpeth River, and West Harpeth River are also designated for domestic and/or industrial water supply.

Water Quality Targets:

Derived from *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January, 2004* for recreation use classification (most stringent):

> The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL. In addition, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall

not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

TMDL Scope:

Waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli. TMDLs were developed for impaired waterbodies on a HUC-12 subwatershed or waterbody drainage area basis.

Analysis/Methodology:

The TMDLs for impaired waterbodies in the Harpeth River Watershed were developed using a load duration curve methodology to assure compliance with the E. Coli 126 CFU/100 mL geometric mean and 941 CFU/100 mL maximum water quality criteria. A duration curve is a cumulative frequency graph that represents the percentage of time during which the value of a given parameter is equaled or exceeded. Load duration curves are developed from flow duration curves and can illustrate existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the region of the waterbody flow regime represented by these existing loads. Load duration curves were used to determine the load reductions required to meet desired maximum concentrations for E. coli. When sufficient data were available, load reductions were also determined based on geometric mean criteria.

Critical Conditions:

Water quality data collected over a period of 10 years for load duration curve analysis were used to assess the water quality standards representing a range of hydrologic and meteorological conditions.

Seasonal Variation:

The 10-year period used for LSPC model simulation period for development of load duration curve analysis included all seasons and a full range of flow and meteorological conditions.

Margin of Safety (MOS):

Explicit MOS = 10% of the E. coli water quality criteria for each impaired subwatershed or drainage area.

Summary of TMDLs, WLAs, & LAs for Impaired Waterbodies

HUC-12 Subwatershed (05130204__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs				LAs	
				WWTFs [a]		CAFOs	MS4s [d]	Precipitation Induced Nonpoint Sources	Other Direct Sources [e]
				Monthly Avg.	Daily Max.				
			[% Red.]	[CFU/day]	[CFU/day]	[CFU/day]	[% Red.]	[% Red.]	[CFU/day]
0101	Kelley Creek	TN05130204018 – 0400	>60.8	8.584×10^{7}	6.411×10^{8}	0	>64.7	>64.7	0
0105	Five Mile Creek	TN05130204016 – 1100	>60.8	5.742×10^{10} [b]	4.288×10^{11} [b]	0	>64.7	>64.7	0
	Harpeth River	TN05130204016 – 2000							
0201	West Harpeth River	TN05130204013 – 2000	>60.8	NA	NA	0	>64.7	>64.7	0
0202	W. Prong Murfrees Fork	TN05130204013 – 0730	>60.8	NA	NA	0	>64.7	>64.7	0
	Murfrees Fork	TN05130204013 – 0750							
0302	Little Harpeth River	TN05130204021 - 1000	36.8	NA	NA	0	43.2	43.2	0
DA	Trace Creek	TN05130204001 – 0600	>60.8	2.385×10^{9} [c]	1.781×10^{10} [c]	0	>64.7	>64.7	0
DA	Arkansas Creek	TN05130204010 - 0600	>60.8	NA	NA	0	>64.7	>64.7	0
0601	Jones Creek	TN05130204002 – 2000	>60.8	1.431×10^{10}	1.069×10^{11}	0	>64.7	>64.7	0
DA (in 0604)	Jones Creek	TN05130204002 – 2000	>60.8	NA	NA	0	>64.7	>64.7	0

Notes: NA = Not Applicable.

a. Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.

b. The WLA listed is for the subwatershed and is equal to the sum of the WLAs for the individual facilities. WLAs for individual WWTFs corresponds to existing E. coli permit limits at facility design flow.

c. The WLAs listed apply to NPDES permitted discharges from WWTFs only. Pathogen loading due to collection system failure is considered to be unpermitted point source loading from the municipal WWTF. With respect to pathogen loading from leaking collection systems, a WLA of zero is assigned. It is recognized, however, that a WLA of 0 CFU/day may not be practical. For these unpermitted sources, the WLA is interpreted to mean a reduction in pathogen loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

d. Applies to any MS4 discharge loading in the subwatershed.

e. The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 CFU/day may not be practical. For these sources, the LA is interpreted to mean a reduction in pathogen loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

PROPOSED E. COLI TOTAL MAXIMUM DAILY LOAD (TMDL) HARPETH RIVER WATERSHED (HUC 05130204)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those waterbodies that are not attaining water quality standards. State water quality standards consist of designated uses for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses, and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources (USEPA, 1991).

2.0 SCOPE OF DOCUMENT

This document presents details of TMDL development for waterbodies in the Harpeth River Watershed, identified on the Final 2004 303(d) list as not supporting designated uses due to E. coli. TMDL analyses were performed primarily on a 12-digit hydrologic unit area (HUC-12) basis. In some cases, where appropriate, TMDLs were developed for an impaired waterbody drainage area only.

3.0 WATERSHED DESCRIPTION

The Harpeth River Watershed (HUC 05130204) is located in Middle Tennessee (Figure 1), primarily in Williamson County. The Harpeth River Watershed lies within one Level III ecoregion (Interior Plateau) and contains three Level IV ecoregions as shown in Figure 2 (USEPA, 1997):

- **Western Highland Rim (71f)** is characterized by dissected, rolling terrain of open hills, with elevations of 400 to 1000 feet. The geologic base of Mississippian-age limestone, chert, and shale is covered by soils that tend to be cherty, acidic and low to moderate in fertility. Streams are characterized by coarse chert gravel and sand substrates with areas of bedrock, moderate gradients, and relatively clear water. The oak-hickory natural vegetation was mostly deforested in the mid to late 1800's, in conjunction with the iron ore related mining and smelting of the mineral limonite, but now the region is again heavily forested. Some agriculture occurs on the flatter areas between streams and in the stream and river valleys: mostly hay, pasture, and cattle, with some cultivation of corn and tobacco.

- **Outer Nashville Basin (71h)** is a heterogeneous region, with rolling and hilly topography and slightly higher elevations. The region encompasses most all of the outer areas of the generally no-cherty Mississippian-age formations, and some Devonian-age Chattanooga shale, remnants of the Highland Rim. The region's limestone rocks and soils are high in phosphorus, and commercial phosphate is mined. Deciduous forest with pasture and cropland are the dominant land covers. Streams are low to moderate gradient, with productive, nutrient-rich waters, resulting in algae, rooted vegetation and occasionally high densities of fish. The Nashville Basin as a whole has a distinctive fish fauna, notable for fish that avoid the region, as well as those that are present.

- **Inner Nashville Basin (71i)** is less hilly and lower than the Outer Nashville Basin. Outcrops of the Ordovician-age limestone are common, and the generally shallow soils are redder and lower in phosphorus than those of the Outer Basin. Streams are lower gradient than surrounding regions, often flowing over large expanses of limestone bedrock. The most characteristic hardwoods within the Inner Basin are a maple-oak-hickory-ash association. The limestone cedar glades of Tennessee, a unique mixed grassland/forest/cedar glades vegetation type with many endemic species, are located primarily on the limestone of the Inner Nashville Basin. The more xeric, open characteristics and shallow soils of the cedar glades also result in a distinct distribution of amphibian and reptile species.

The Harpeth River Watershed, located in Cheatham, Davidson, Dickson, Hickman, Rutherford, and Williamson Counties, Tennessee, has a drainage area of approximately 869 square miles (mi^2). Watershed land use distribution is based on the Multi-Resolution Land Characteristic (MRLC) databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Although changes in the land use of the Harpeth River Watershed have occurred since 1993 as a result of development, this is the most current land use data available. Land use for the Harpeth River Watershed is summarized in Table 1 and shown in Figure 3. Predominant land use in the Harpeth River Watershed is forest (62.5%) followed by pasture (23.4%). Urban areas represent approximately 3.0% of the total drainage area of the watershed. Details of land use distribution of impaired subwatersheds in the Harpeth River Watershed are presented in Appendix A.

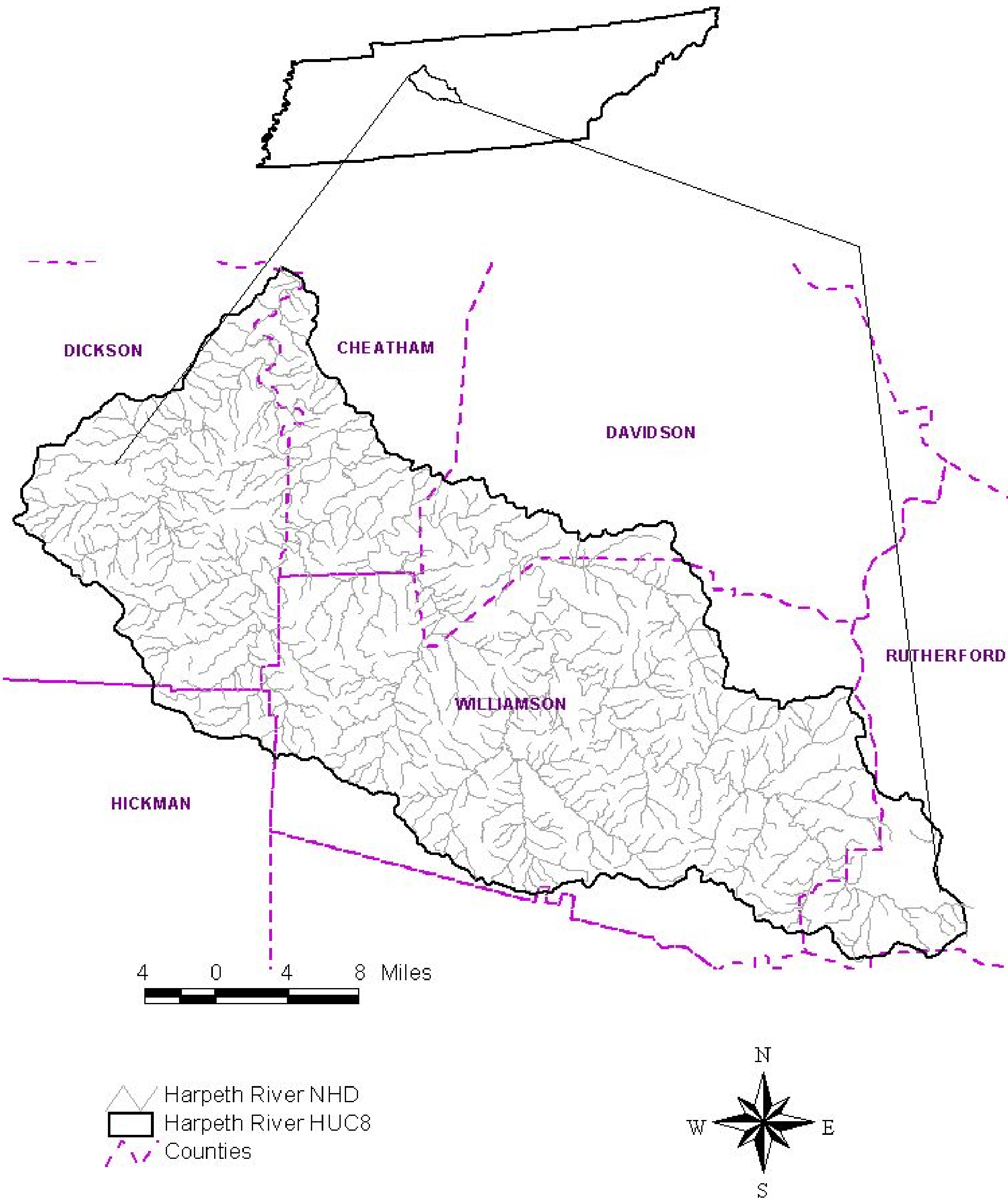

Figure 1. Location of the Harpeth River Watershed.

Figure 2. Level IV Ecoregions in the Harpeth River Watershed.

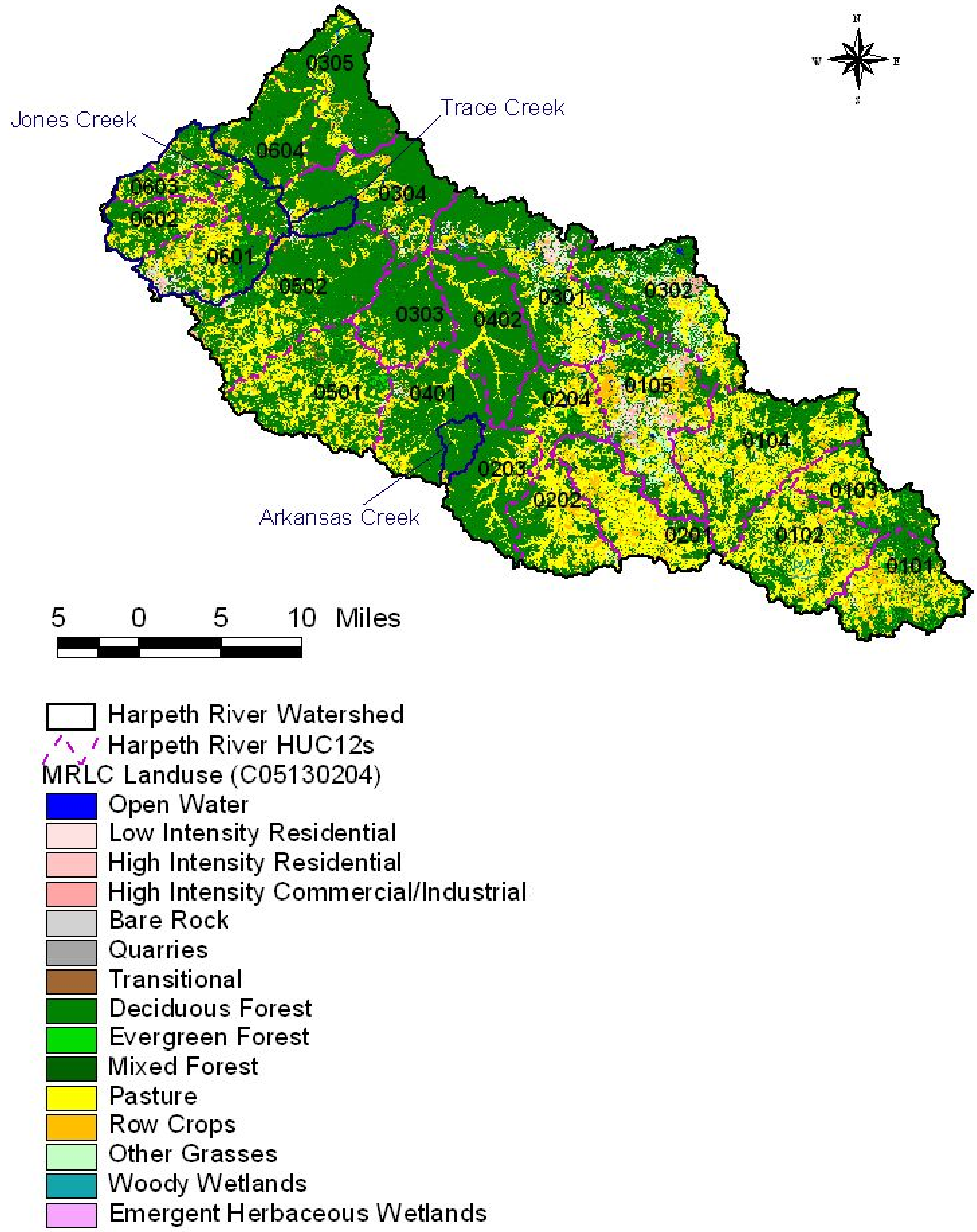

Figure 3. Land Use Characteristics of the Harpeth River Watershed.

Table 1. MRLC Land Use Distribution – Harpeth River Watershed

Land Use	Area	
	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0
Deciduous Forest	278,593	50.1
Emergent Herbaceous Wetlands	13	0.0
Evergreen Forest	13,984	2.5
High Intensity Commercial/Industrial/ Transportation	5,035	0.9
High Intensity Residential	1,214	0.2
Low Intensity Residential	10,373	1.9
Mixed Forest	54,820	9.9
Open Water	2,189	0.4
Other Grasses (Urban/recreational)	8,192	1.5
Pasture/Hay	130,295	23.4
Quarries/Strip Mines/ Gravel Pits	325	0.1
Row Crops	49,042	8.8
Transitional	1,074	0.2
Woody Wetlands	758	0.1
Total	**555,906**	**100.0**

4.0 PROBLEM DEFINITION

The State of Tennessee's final 2004 303(d) list (TDEC, 2004a) was approved by the U.S. Environmental Protection Agency (EPA), Region IV in August of 2005. This list identified portions of eight waterbodies in the Harpeth River Watershed as not supporting designated use classifications due, in part, to E. coli (see Table 2 & Figure 4). The designated use classifications for these waterbodies include fish and aquatic life, irrigation, livestock watering & wildlife, and recreation. Trace Creek, Jones Creek, Harpeth River, and West Harpeth River are also designated for industrial water supply. West Harpeth River and portions of Harpeth River (mile 57.8 to mile 61.9, mile 68.3 to mile 79.0, and mile 85.2 to origin; none of these segments are impaired for E.coli) are also designated for domestic water supply.

When used in the context of waterbody assessments, the term pathogens is defined as disease-causing organisms such as bacteria or viruses that can pose an immediate and serious health threat if ingested or introduced into the body. The primary sources for pathogens are untreated or inadequately treated human or animal fecal matter. The E. coli and fecal coliform groups are indicators of the presence of pathogens in a stream.

5.0 WATER QUALITY CRITERIA & TMDL TARGET

As previously stated, the designated use classifications for the Harpeth River waterbodies include fish & aquatic life, recreation, irrigation, and livestock watering & wildlife. Of the use classifications with numeric criteria for pathogens, the recreation use classification is the most stringent and will be used to establish target levels for TMDL development. The coliform water quality criteria, for protection of the recreation use classification, is established by *State of Tennessee Water Quality Standards, Chapter 1200-4-3, General Water Quality Criteria, January 2004* (TDEC, 2004b). Section 1200-4-3-.03 (4) (f) states:

> The concentration of the E. coli group shall not exceed 126 colony forming units per 100 mL, as a geometric mean based on a minimum of 5 samples collected from a given sampling site over a period of not more than 30 consecutive days with individual samples being collected at intervals of not less than 12 hours. For the purposes of determining the geometric mean, individual samples having an E. coli concentration of less than 1 per 100 mL shall be considered as having a concentration of 1 per 100 mL.
>
> Additionally, the concentration of the E. coli group in any individual sample taken from a lake, reservoir, State Scenic River, or Tier II or III stream (1200-4-3-.06) shall not exceed 487 colony forming units per 100 mL. The concentration of the E. coli group in any individual sample taken from any other waterbody shall not exceed 941 colony forming units per 100 mL.

Several portions of the Harpeth River in Cheatham and Davidson counties have been classified as Tier II. A portion of the Harpeth River in Williamson county (from Nelson Creek to unnamed tributary just downstream of Hwy 31A and the portion in Haley-Jaqueth Wildlife Management Area) also has been classified as Tier II. A portion of Jones Creek (from Will Hall Creek to Spicer Branch – in Montgomery Bell State Park and Natural Area) has been classified as Tier II. Kelly Creek (ID 05130204010 – from South Harpeth River to headwaters) has been classified as Tier II, however Kelley Creek (ID 05130204018 – from Harpeth River to headwaters) has not been classified as Tier II or Tier III.

As of February 2, 2006, none of the E. coli impaired waterbodies in the Harpeth River Watershed have been classified as either Tier II or Tier III streams.

The geometric mean standard for the E. coli group of 126 colony forming units per 100 ml (CFU/100 ml) and the sample maximum of 941 CFU/100 ml have been selected as the appropriate numerical targets for TMDL development.

Table 2 Final 2004 303(d) List for E. coli Impaired Waterbodies – Harpeth River Watershed

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired	Cause (Pollutant)	Pollutant Source
TN05130204001 – 0600	TRACE CREEK	8.3	Escherichia coli	Collection System Failure
TN05130204002 – 2000	JONES CREEK	7.0	Nutrients Escherichia coli	Municipal Point Source Pasture Grazing
TN05130204010 - 0600	ARKANSAS CREEK	5.7	Escherichia coli	Undetermined Source
TN05130204013 – 0730	WEST PRONG MURFREES FORK	6.0	Low dissolved oxygen Escherichia coli	Pasture Grazing
TN05130204013 – 0750	MURFREES FORK	18.4	Loss of biological integrity due to siltation Escherichia coli	Pasture Grazing
TN05130204013 – 2000	WEST HARPETH RIVER	10.9	Escherichia coli	Pasture Grazing
TN05130204016 – 1100	FIVEMILE CREEK	14.4	Loss of biological integrity due to siltation Escherichia coli	Pasture Grazing
TN05130204016 – 2000	HARPETH RIVER	3.9	Low Dissolved Oxygen Phosphate Loss of biological integrity due to siltation Escherichia coli	Discharges from MS4 Area Highways, Roads, Bridges, Infrastructure Construction Pasture Grazing
TN05130204018 – 0400	KELLEY CREEK	9.3	Habitat loss due to alteration in stream-side or littoral vegetative cover Loss of biological integrity due to siltation Escherichia coli	Pasture Grazing
TN05130204021 - 1000	LITTLE HARPETH RIVER	4.1	Low Dissolved Oxygen Habitat loss due to alteration in stream-side or littoral vegetative cover Loss of biological integrity due to siltation Escherichia coli	Land Development

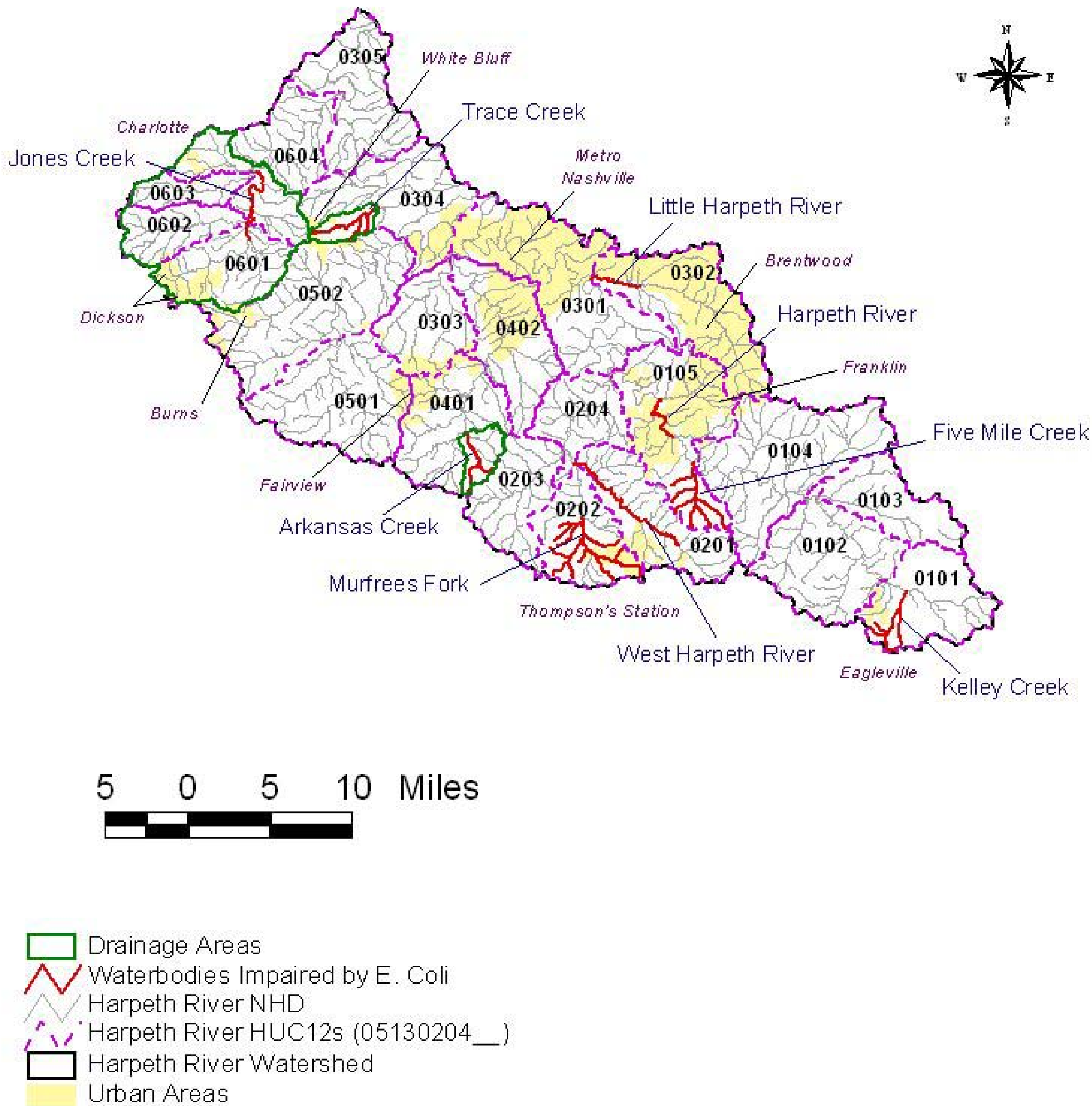

Figure 4. Waterbodies Impaired by E. Coli (as Documented on the Final 2004 303(d) List).

6.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

There are several water quality monitoring stations that provide data for waterbodies identified as impaired for E. coli in the Harpeth River Watershed:

- ARKAN000.1WI – Arkansas Creek, off old SR 96, d/s of landfill
- FIVEM001.4WI – Five Mile Creek, at Old Peytonsville Rd.
- HARPE079.8WI – Harpeth River, at Cotton Rd., d/s of Franklin
- HARPE092.4WI – Harpeth River, off Rivergate Dr., under I-65
- JONES010.1DI – Jones Creek, at Petty Rd.
- JONES019.6DI – Jones Creek, off Jones Creek Rd., d/s of Dickson STP
- KELLE000.4RU – Kelley Creek, at Swamp Rd.
- LHARP001.0WI – Little Harpeth River, in Warner Park, d/s Brentwood PS
- LJONE000.8DI – Little Jones Creek, at Willow Branch Rd.
- MURFR003.9WI – Murfrees Fork, at Highway 246 (Carters Creek Pike)
- TOWNB003.4DI – Town Branch, at Corlew Cemetery Rd.
- TRACE003.5DI – Trace Creek, off Trace Creek Rd., d/s of White Bluff STP
- WHARP000.3WI – West Harpeth River, at Del Rio Pike
- WHARP017.7WI – West Harpeth River, at West Harpeth Rd.

The location of these monitoring stations is shown in Figure 5. Water quality monitoring results for these stations are tabulated in Appendix C. Examination of the data shows exceedances of the 941 CFU/100 mL maximum E. coli standard at many monitoring stations. Water quality monitoring results for those stations with 10% or more of samples exceeding water quality maximum criteria are summarized in Table 3.

There were not enough data to calculate the geometric mean at each monitoring station. Whenever a minimum of 5 samples was collected at a given monitoring station over a period of not more than 30 consecutive days, the geometric mean was calculated.

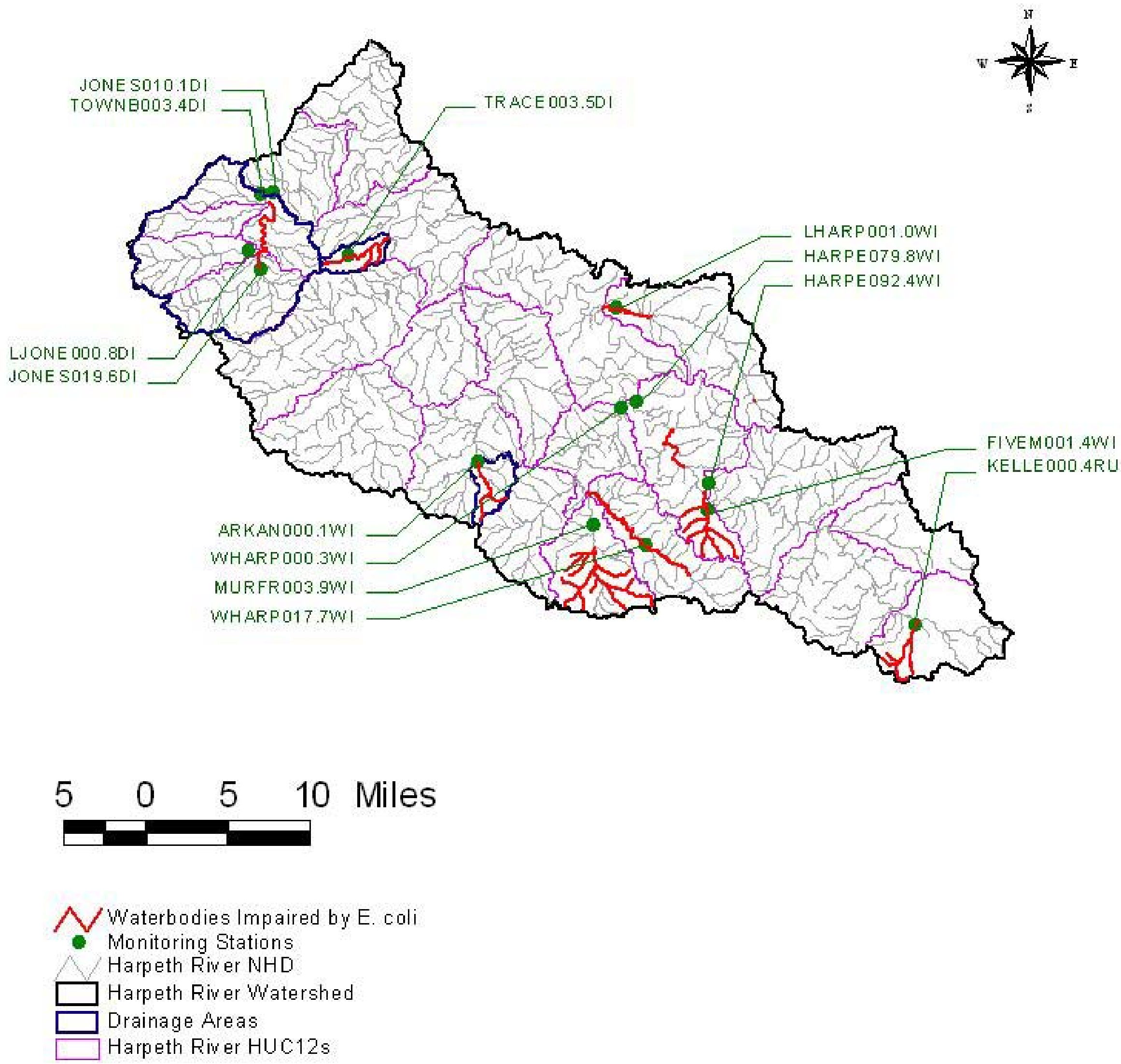

Figure 5. Water Quality Monitoring Stations in the Harpeth River Watershed

Table 3 Summary of TDEC Water Quality Monitoring Data

Monitoring Station	Date Range	E. Coli (Max WQ Target = 941 Counts/100 mL)				
		Data Pts.	Min. [CFU/100 ml]	Avg. [CFU/100 ml]	Max. [CFU/100 ml]	No. Exceed. WQ Max. Target
ARKAN000.1WI	2001 – 2002	11	100	1,130	>2,400	5
FIVEM001.4WI	2001 – 2002	9	490	1,460	>2,400	6
HARPE079.8WI	2001 – 2002	9	37	840	>2,400	3
HARPE092.4WI	2001 – 2002	9	44	806	>2,400	3
JONES019.6DI	2001 – 2002	7	370	1,570	>2,400	5
KELLE000.4RU	2001 – 2002	9	25	923	>2,400	3
LHARP001.0WI	2001 – 2002	8	32	623	>2,400	3
MURFR003.9WI	2001 – 2002	9	490	1,422	>2,400	5
TOWNB003.4DI	2001 – 2002	7	40	620	1,300	2
TRACE003.5DI	2001 – 2002	8	61	1,220	>2,400	5
WHARP017.7WI	2001 – 2002	9	290	1,099	>2,400	2

7.0 SOURCE ASSESSMENT

An important part of TMDL analysis is the identification of individual sources, or source categories of pollutants in the watershed that affect pathogen loading and the amount of loading contributed by each of these sources.

Under the Clean Water Act, sources are classified as either point or nonpoint sources. Under 40 CFR §122.2, a point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Point sources can be described by three broad categories: 1) NPDES regulated municipal and industrial wastewater treatment facilities (WWTFs); 2) NPDES regulated industrial and municipal storm water discharges; and 3) NPDES regulated Concentrated Animal Feeding Operations (CAFOs). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES regulated point sources. Nonpoint sources are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For the purposes of this TMDL, all sources of pollutant loading not regulated by NPDES permits are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

7.1 Point Sources

7.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

Both treated and untreated sanitary wastewater contain coliform bacteria. There are 21 WWTFs in the Harpeth River Watershed that have NPDES permits authorizing the discharge of treated sanitary wastewater. Six of these facilities are located in impaired subwatersheds or drainage areas (see Table 4 & Figure 6). The permit limits for discharges from these WWTFs are in accordance with the coliform criteria specified in Tennessee Water Quality Standards for the protection of the recreation use classification.

Note: As stated in Section 5.0, the current coliform criteria are expressed in terms of E. coli concentration, whereas previous criteria were expressed in terms of fecal coliform and E. coli concentration. Due to differences in permit issuance dates, some permits still have fecal coliform limits instead of E. coli. As permits are reissued, limits for fecal coliform will be replaced by E. coli limits.

Table 4 NPDES Permitted WWTFs in Impaired Subwatersheds or Drainage Areas

NPDES Permit No.	Facility	Design Flow [MGD]	Receiving Stream
TN0028827	Franklin STP	12.0	Harpeth River at RM 85.2
TN0060216	Goose Creek Inn	0.03 *	Five Mile Creek at RM 2.2
TN0067873	Oakview Elementary School	0.01	Unnamed tributary to Five Mile Creek at RM 1.1
TN0057789	Eagleville High School	0.018	Cheatham Branch at RM 1.9
TN0066958	Dickson STP	4.0	Jones Creek at RM 21.7
TN0020460	White Bluff STP	0.5	Trace Creek at RM 4.3

* Long term average flow is used for industrial facilities.

A summary of effluent monitoring data, submitted on Discharge Monitoring Reports (DMRs) for the period from July 2002 to November 2005, for facilities that are located in HUC-12 subwatersheds or drainage areas containing waterbodies impaired for pathogens is presented in Table 5. DMRs are not required for “package plants” such as those in operation at Goose Creek Inn and the schools. Monthly Operation Reports (MORs) are submitted to the local Environmental Field Office.

Table 5 Summary of DMRs for NPDES Permitted WWTFs in Impaired Subwatersheds or Drainage Areas

NPDES Permit No.	E. Coli (Permit Limit = 126 CFU/100 mL Avg.)					Fecal Coliform (Permit Limit = 200 CFU/100 mL Avg.)					Fecal Coliform (Permit Limit = 1000 CFU/100 mL Max.)					No. Bypass/ Overflow Events
	Data Pts.	Min. (CFU/100 mL)	Avg. (CFU/100 mL)	Max. (CFU/100 mL)	No. Exceed.	Data Pts.	Min. (CFU/100 mL)	Avg. (CFU/100 mL)	Max. (CFU/100 mL)	No. Exceed.	Data Pts.	Min. (CFU/100 mL)	Avg. (CFU/100 mL)	Max. (CFU/100 mL)	No. Exceed.	
TN0020460	41	0	68	481	5	41	0	82	381	2	41	54	775	10000	6	66
TN0028827	39	1	2	39	0	38	1	1	4	0	38	1	25	240	0	14
TN0066958	No Data Available					40	3	21	68	0	40	23	258	940	0	15

Due to differences in permit issuance dates, some permits still have fecal coliform limits instead of E. coli. As permits are reissued, limits for fecal coliform will be replaced by E. coli limits. Fecal coliform data are presented for informational purposes only.

According to a Compliance Evaluation Inspection conducted in December 2004, the White Bluff STP collection system is in need of repair and compliance status is marginal.

According to a Compliance Evaluation Inspection conducted in June 2005, the Franklin STP was operating in compliance with its permit. Effluent discharge to the Harpeth River was described as “very clear”.

According to a Compliance Evaluation Inspection conducted in June 2000, the Dickson STP was operating in compliance with its permit. A new permit, which allowed for expanded capacity, was issued in November 2005.

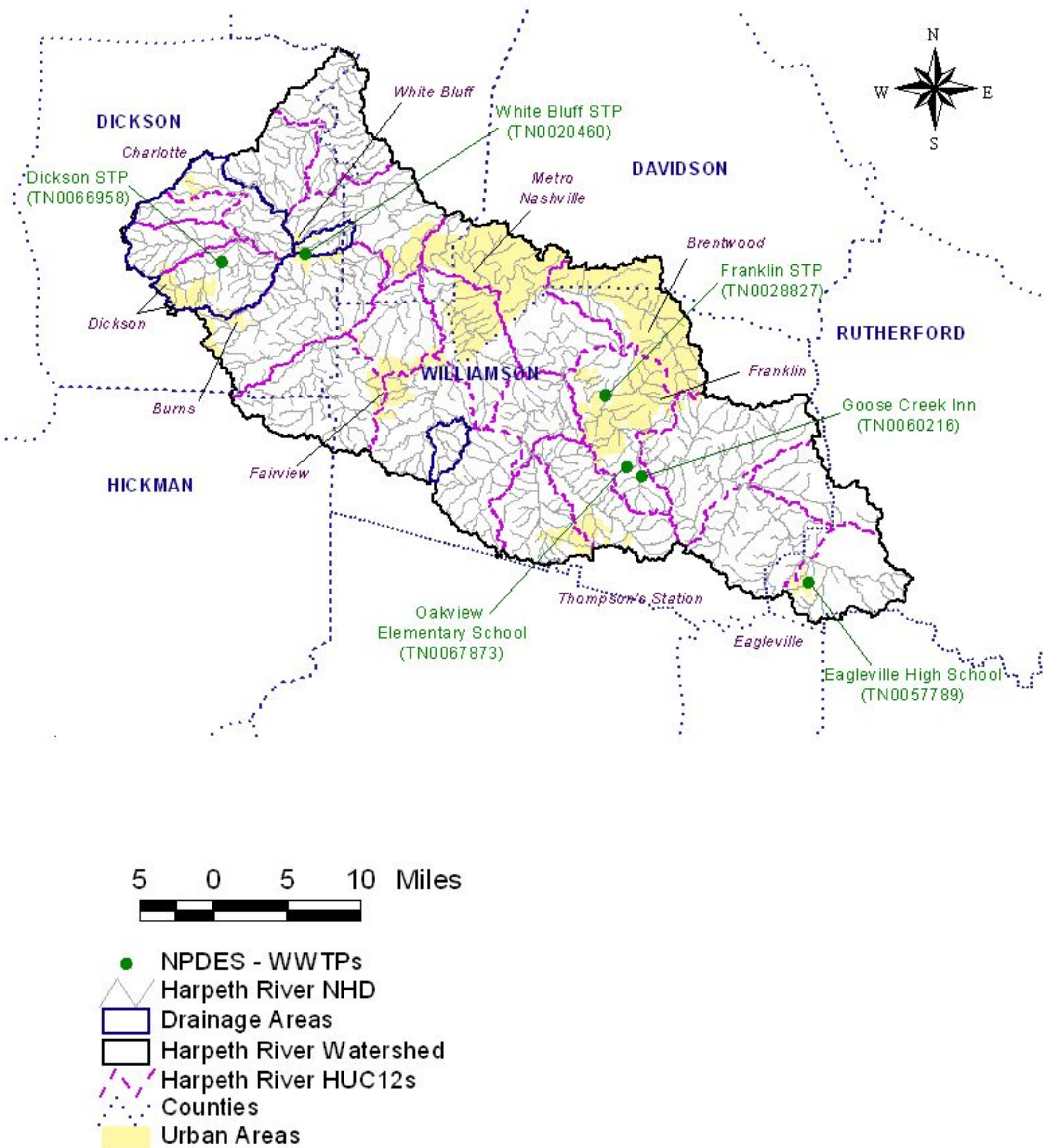

Figure 6. NPDES Regulated Point Sources in and near Impaired Subwatersheds and Drainage Areas of the Harpeth River Watershed.

7.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

Municipal Separate Storm Sewer Systems (MS4s) are considered to be point sources of E. coli. Discharges from MS4s occur in response to storm events through road drainage systems, curb and gutter systems, ditches, and storm drains. Large and medium MS4s serving populations greater than 100,000 people are required to obtain NPDES storm water permits. At present, Metro Nashville/Davidson County is the only large or medium (Phas I) MS4 in the Harpeth River Watershed.

As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2002). An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile. Brentwood, Dickson, Franklin, Rutherford County, and Williamson County are covered under Phase II of the NPDES Storm Water Program. The Tennessee Department of Transportation (TDOT) is also being issued Phase II MS4 permits for State roads in urban areas. Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at:

http://www.state.tn.us/environment/wpc/stormh2o/.

Information regarding municipal storm water management programs is available at the following websites:

http://www.nashville.gov/stormwater/ns_index/htm
http://brentwood-tn.org/Stormwater/stormwater.htm
http://www.cityofdickson.com (currently under construction)
http://www.franklin-gov.com/engineering/STORMWATER/stormwater.htm

7.1.3 NPDES Concentrated Animal Feeding Operations (CAFOs)

Animal feeding operations (AFOs) are agricultural enterprises where animals are kept and raised in confined situations. AFOs congregate animals, feed, manure and urine, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures, fields, or on rangeland (USEPA, 2002a). Concentrated Animal Feeding Operations (CAFOs) are AFOs that meet certain criteria with respect to animal type, number of animals, and type of manure management system. CAFOs are considered to be potential point sources of pathogen loading and are required to obtain an NPDES permit. Most CAFOs in Tennessee obtain coverage under TNA000000, *Class II Concentrated Animal Feeding Operation General Permit*, while larger, Class I CAFOs are required to obtain an individual NPDES permit.

As of May 11, 2005, there are no Class II CAFOs in the Harpeth River watershed with coverage under the general NPDES permit. There are also no Class I CAFOs with individual permits located in the watershed.

7.2 Nonpoint Sources

Nonpoint sources of coliform bacteria are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not always, involve accumulation of coliform bacteria on land surfaces and wash off as a result of storm events. Nonpoint sources of E. coli loading are primarily associated with agricultural and urban land uses. The majority of waterbodies identified on the Final 2004 303(d) list as impaired due to E. coli are attributed to nonpoint agricultural or urban sources.

7.2.1 Wildlife

Wildlife deposit coliform bacteria, with their feces, onto land surfaces where it can be transported during storm events to nearby streams. The overall deer density for Tennessee was estimated by the Tennessee Wildlife Resources Agency (TWRA) to be 23 animals per square mile.

7.2.2 Agricultural Animals

Agricultural activities can be a significant source of coliform bacteria loading to surface waters. The activities of greatest concern are typically those associated with livestock operations:

- Agricultural livestock grazing in pastures deposit manure containing coliform bacteria onto land surfaces. This material accumulates during periods of dry weather and is available for washoff and transport to surface waters during storm events. The number of animals in pasture and the time spent grazing are important factors in determining the loading contribution.
- Processed agricultural manure from confined feeding operations is often applied to land surfaces and can provide a significant source of coliform bacteria loading. Guidance for issues relating to manure application is available through the University of Tennessee Agricultural Extension Service and the Natural Resources Conservation Service (NRCS).
- Agricultural livestock and other unconfined animals often have direct access to waterbodies and can provide a concentrated source of coliform bacteria loading directly to a stream.

Data sources related to livestock operations include the 2002 Census of Agriculture, which was compiled for the Harpeth Watershed utilizing the Watershed Characterization System (WCS). WCS is an Arcview geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. Livestock information provided in WCS is based on the ratio of watershed pasture area to county pasture area applied to the livestock population within the county. Livestock data for E. coli-impaired watersheds are summarized in Table 6. Populations were rounded to the nearest 25 cows, 50 poultry, and 5 hogs, sheep, and horses.

Table 6 Livestock Distribution in the Harpeth River Watershed

HUC-12 Subwatershed (05130204__) or Drainage Area	Livestock Population (WCS)					
	Beef Cow	Milk Cow	Poultry	Hogs	Sheep	Horse
0101 (Kelley Ck)	1,175	100	2,500	60	45	345
0105 (Harpeth)	2,050	75	150	90	75	410
0201 (W. Harpeth)	1,425	50	100	60	95	535
0202 (Murfrees Fk)	1,150	50	100	50	70	380
0302 (L. Harpeth)	1,425	50	100	60	50	310
Trace Creek DA	600	0	100	70	5	120
Arkansas Creek DA	275	0	0	10	0	10
0601 (Jones Ck)	850	0	150	105	15	260
Jones Creek DA (in 0604)	650	0	100	80	10	125

Table 7 Population on Septic Systems in the Harpeth River Watershed

HUC-12 Subwatershed (05130204__) or Drainage Area	Population on Septic Systems
0101 (Kelley Ck)	6,452
0105 (Harpeth)	2,209
0201 (W. Harpeth)	1,640
0202 (Murfrees Fk)	1,365
0302 (L. Harpeth)	8,545
Trace Creek DA	445
Arkansas Creek DA	314
0601 (Jones Ck)	1,917
Jones Creek DA (in 0604)	1,422

7.2.3 Failing Septic Systems

Some coliform loading in the Harpeth River Watershed can be attributed to failure of septic systems and illicit discharges of raw sewage. Estimates from 1997 county census data of people in the Harpeth River Watershed utilizing septic systems were compiled using the WCS and are summarized in Table 7. In middle and eastern Tennessee, it is estimated that there are approximately 2.37 people per household on septic systems, some of which can be reasonably assumed to be failing. As with livestock in streams, discharges of raw sewage provide a concentrated source of coliform bacteria directly to waterbodies.

7.2.4 Urban Development

Nonpoint source loading of coliform bacteria from urban land use areas is attributable to multiple sources. These include: stormwater runoff, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals. Impervious surfaces in urban areas allow runoff to be conveyed to streams quickly, without interaction with soils and groundwater. Urban land use area in impaired subwatersheds in the Harpeth River Watershed ranges from 0.6% to 4.0%. Land use for the Harpeth River impaired drainage areas is summarized in Figures 7 thru 10 and tabulated in Appendix A.

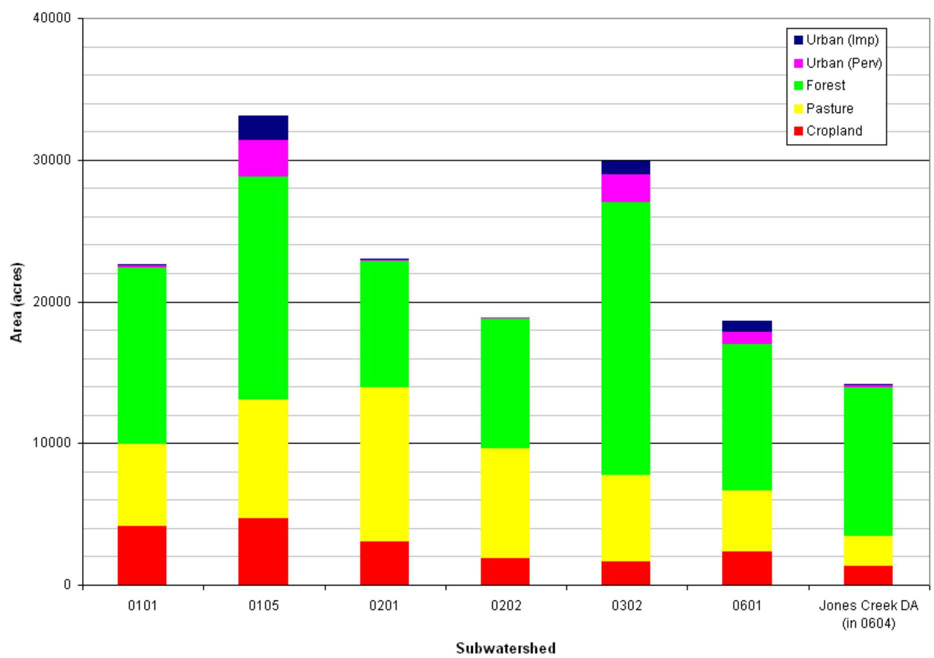

Figure 7. Land Use Area of Harpeth River Pathogen-Impaired Subwatersheds – Drainage Areas Greater Than 15,000 Acres.

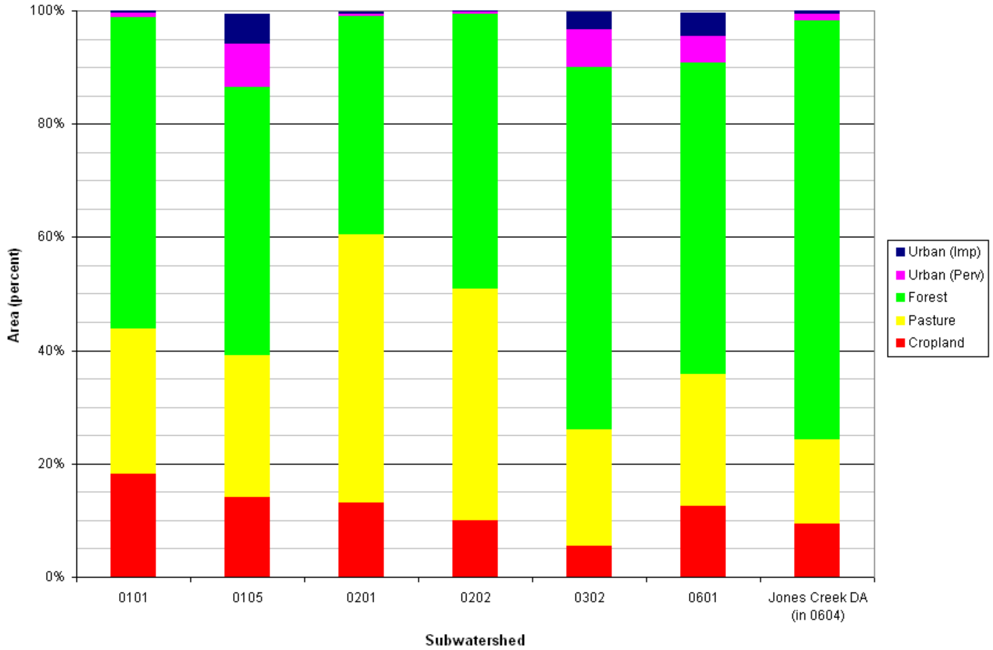

Figure 8. **Land Use Percent of the Harpeth River Pathogen-Impaired Subwatersheds – Drainage Areas Greater Than 15,000 Acres.**

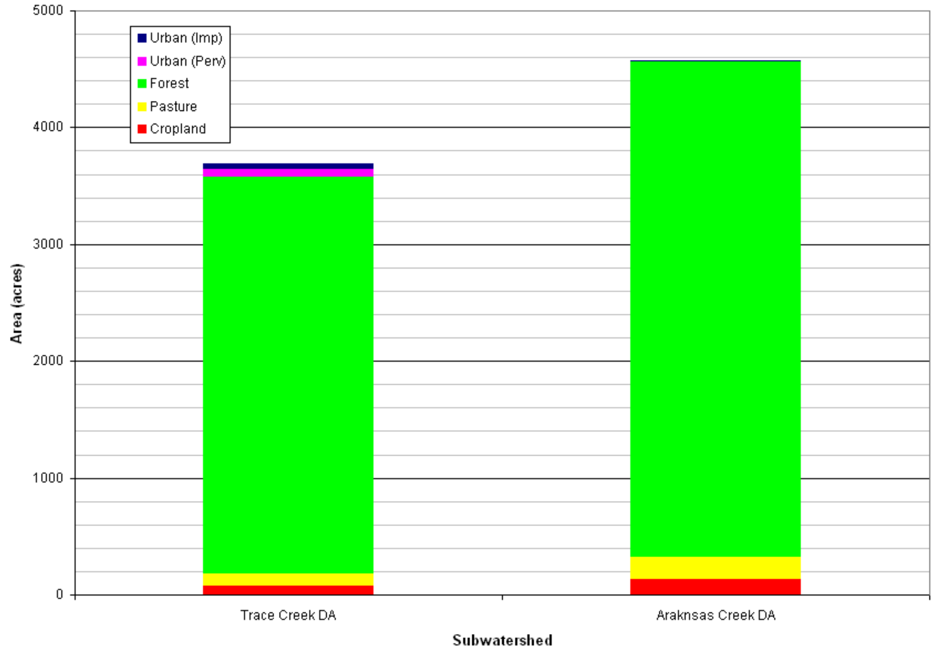

Figure 9. Land Use Area of Harpeth River Pathogen-Impaired Subwatersheds – Drainage Areas Less Than 5,000 Acres.

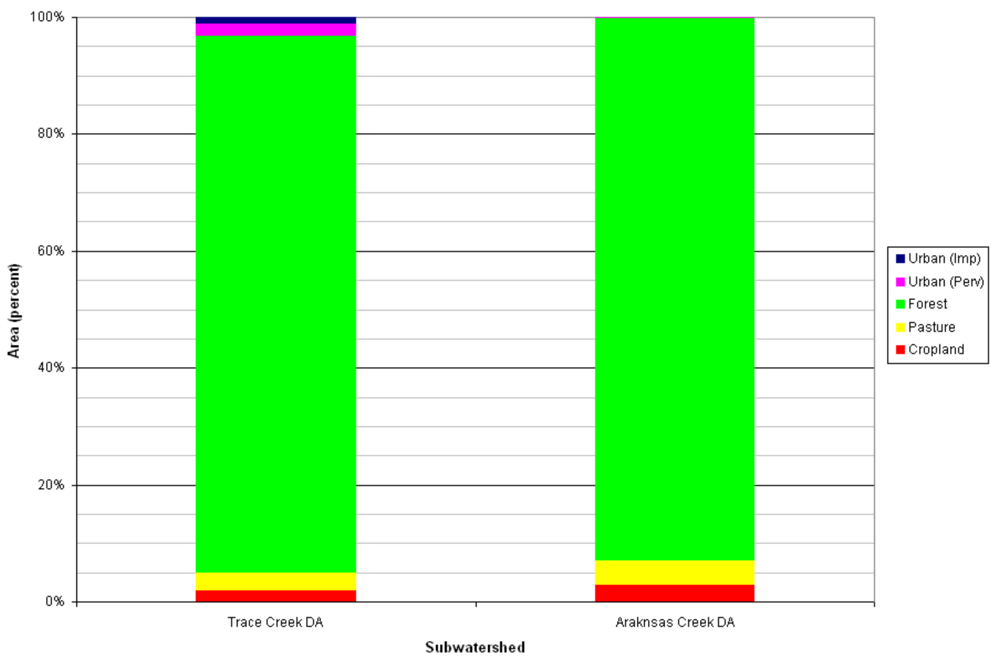

Figure 10. Land Use Percent of the Harpeth River Pathogen-Impaired Subwatersheds – Drainage Areas Less Than 5,000 Acres.

8.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOADS

The Total Maximum Daily Load (TMDL) process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or <u>other appropriate measure</u>.

This document describes TMDL, Waste Load Allocation (WLA), and Load Allocation (LA) development for waterbodies identified as impaired due to E. coli on the Final 2004 303(d) list.

8.1 Expression of TMDLs, WLAs, & LAs

In this document, TMDLs are expressed as the percent reduction in instream loading required to decrease existing E. coli concentrations to desired target levels. WLAs & LAs for precipitation-induced loading sources are also expressed as required percent reductions in E. coli loading. Allocations for loading that is independent of precipitation (WLAs for WWTFs and LAs for “other direct sources”) are expressed as CFU/day.

8.2 Area Basis for TMDL Analysis

The primary area unit of analysis for TMDL development was the HUC-12 subwatershed containing one or more waterbodies assessed as impaired due to E. coli (as documented on the 2004 303(d) List). In some cases, however, TMDLs were developed for an impaired waterbody drainage area only. Determination of the appropriate area to use for analysis (see Table 8) was based on a careful consideration of a number of relevant factors, including: 1) location of impaired waterbodies in the HUC-12 subwatershed; 2) land use type and distribution; 3) water quality monitoring data; and 4) the assessment status of other waterbodies in the HUC-12 subwatershed.

Table 8 Determination of Analysis Areas for TMDL Development

HUC-12 Subwatershed (05130204____)	Impaired Waterbody	Area
0101	Kelley Creek	HUC-12
0105	Harpeth River Fivemile Creek	HUC-12
0201	West Harpeth River	HUC-12
0202	Murfrees Fork West Prong Murfrees Fork	HUC-12
0302	Little Harpeth River	HUC-12
0304	Trace Creek	DA
0401	Arkansas Creek	DA
0601	Jones Creek	HUC-12
0604	Jones Creek	DA

Note: HUC-12 = HUC-12 Subwatershed
DA = Waterbody Drainage Area

8.3 TMDL Analysis Methodology

TMDLs for the Harpeth River Watershed were developed using load duration curves for analysis of impaired HUC-12 subwatersheds or specific waterbody drainage areas. A load duration curve (LDC) is a cumulative frequency graph that illustrates existing water quality conditions (as represented by loads calculated from monitoring data), how these conditions compare to desired targets, and the portion of the waterbody flow regime represented by these existing loads. Load duration curves are considered to be well suited for analysis of periodic monitoring data collected by grab sample. LDCs were developed at monitoring site locations in impaired waterbodies and an overall load reduction calculated to meet E. coli targets according to the methods described in Appendix C.

8.4 Critical Conditions and Seasonal Variation

The critical condition for non-point source E. coli loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, E. coli bacteria builds up on the land surface, and is washed off by rainfall. The critical condition for point source loading occurs during periods of low streamflow when dilution is minimized. Both conditions are represented in the TMDL analysis.

The ten-year period from October 1, 1994 to September 30, 2004 was used to simulate flow. This 10-year period contained a range of hydrologic conditions that included both low and high streamflows. Critical conditions are accounted for in the load duration curve analysis by using the entire period of flow and water quality data available for the impaired waterbodies. In all subwatersheds, water quality data have been collected during most flow ranges. Based on the location of the water quality exceedances on the load duration curves, no one delivery mode for E. oli appears to be dominant (see Section 9.3 and Table 9).

Seasonal variation was incorporated in the load duration curves by using the entire simulation period and all water quality data collected at the monitoring stations. The water quality data were not collected during all seasons.

8.5 Margin of Safety

There are two methods for incorporating MOS in TMDL analysis: a) implicitly incorporate the MOS using conservative model assumptions; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. For development of pathogen TMDLs in the Harpeth River Watershed, an explicit MOS, equal to 10% of the E. coli water quality targets (ref.: Section 5.0), was utilized for determination of WLAs and LAs:

Instantaneous Maximum:	MOS = 94 CFU/100 ml
30-Day Geometric Mean:	MOS = 13 CFU/100 ml

8.6 Determination of TMDLs

E. coli load reductions were calculated for impaired segments in the Harpeth Watershed using Load Duration Curves to evaluate compliance with the maximum target concentrations according to the procedure in Appendix C. When sufficient data were available, load reductions were also developed to achieve compliance with the 30-day geometric mean target concentrations. Both instream load reductions (where applicable) for a particular waterbody were compared and the largest required load reduction was selected as the TMDL. These TMDL load reductions for impaired segments are shown in Table 9 and are applied according to the areas specified in Table 8. In cases where the geometric mean could not be developed, it is assumed that achieving the load reduction based on the maximum target concentrations should result in attainment of the geometric mean criteria.

8.7 Determination of WLAs & LAs

WLAs for MS4s and LAs for precipitation induced sources of E. coli loading were determined according to the procedures in Appendix C. These allocations represent the higher load reductions necessary to achieve instream targets <u>after application of the explicit MOS</u>. WLAs for existing WWTFs are equal to their existing NPDES permit limits. Since WWTF permit limits require that E. coli concentrations must comply with water quality criteria (TMDL targets) at the point of discharge and recognition that loading from these facilities are generally small in comparison to other loading sources, further reductions were not considered to be warranted. WLAs for CAFOs and LAs for “other direct sources” (non-precipitation induced) are equal to zero. WLAs, & LAs are summarized in Table 9.

Note: The WLA for WWTFs in Subwatershed 051302040105 is the total allocation for the three facilities located in the subwatershed. The WLA for each individual facility was determined using existing permit limits and design flow.

Table 9 TMDLs, WLAs, & LAs for Impaired Subwatersheds and Drainage Areas in the Harpeth River Watershed

HUC-12 Subwatershed (05130204__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs				LAs	
				WWTFs [a]		CAFOs	MS4s [d]	Precipitation Induced Nonpoint Sources	Other Direct Sources [e]
				Monthly Avg.	Daily Max.				
			[% Red.]	[CFU/day]	[CFU/day]	[CFU/day]	[% Red.]	[% Red.]	[CFU/day]
0101	Kelley Creek	TN05130204018 – 0400	>60.8	8.584×10^{7}	6.411×10^{8}	0	>64.7	>64.7	0
0105	Five Mile Creek	TN05130204016 – 1100	>60.8	5.742×10^{10} [b]	4.288×10^{11} [b]	0	>64.7	>64.7	0
	Harpeth River	TN05130204016 – 2000							
0201	West Harpeth River	TN05130204013 – 2000	>60.8	NA	NA	0	>64.7	>64.7	0
0202	W. Prong Murfrees Fork	TN05130204013 – 0730	>60.8	NA	NA	0	>64.7	>64.7	0
	Murfrees Fork	TN05130204013 – 0750							
0302	Little Harpeth River	TN05130204021 - 1000	36.8	NA	NA	0	43.2	43.2	0
DA	Trace Creek	TN05130204001 – 0600	>60.8	2.385×10^{9} [c]	1.781×10^{10} [c]	0	>64.7	>64.7	0
DA	Arkansas Creek	TN05130204010 - 0600	>60.8	NA	NA	0	>64.7	>64.7	0
0601	Jones Creek	TN05130204002 – 2000	>60.8	1.431×10^{10}	1.069×10^{11}	0	>64.7	>64.7	0
DA (in 0604)	Jones Creek	TN05130204002 – 2000	>60.8	NA	NA	0	>64.7	>64.7	0

Notes: NA = Not Applicable.

a. Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.

b. The WLA listed is for the subwatershed and is equal to the sum of the WLAs for the individual facilities. WLAs for individual WWTFs corresponds to existing E. coli permit limits at facility design flow.

c. The WLAs listed apply to NPDES permitted discharges from WWTFs only. Pathogen loading due to collection system failure is considered to be unpermitted point source loading from the municipal WWTF. With respect to pathogen loading from leaking collection systems, a WLA of zero is assigned. It is recognized, however, that a WLA of 0 CFU/day may not be practical. For these unpermitted sources, the WLA is interpreted to mean a reduction in pathogen loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

d. Applies to any MS4 discharge loading in the subwatershed.

e. The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 CFU/day may not be practical. For these sources, the LA is interpreted to mean a reduction in pathogen loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

9.0 IMPLEMENTATION PLAN

The TMDLs, WLAs, and LAs developed in Section 8 are intended to be the first phase of a long-term effort to restore the water quality of impaired waterbodies in the Harpeth River Watershed through reduction of excessive pathogen loading. Adaptive management methods, within the context of the State's rotating watershed management approach, will be used to modify TMDLs, WLAs, and LAs as required to meet water quality goals.

9.1 Point Sources

9.1.1 NPDES Regulated Municipal and Industrial Wastewater Treatment Facilities

All present and future discharges from industrial and municipal wastewater treatment facilities are required to be in compliance with the conditions of their NPDES permits at all times, including elimination of bypasses and overflows. In Tennessee, permit limits for treated sanitary wastewater require compliance with coliform water quality standards (ref: Section 5.0) prior to discharge. No additional reduction is required. WLAs for WWTFs are derived from facility design flows and permitted E. coli limits and are expressed as average loads in CFU per day.

9.1.2 NPDES Regulated Municipal Separate Storm Sewer Systems (MS4s)

For existing and future regulated discharges from municipal separate storm sewer systems, WLAs will be implemented through Phase I & II MS4 permits. These permits will require the development and implementation of a Storm Water Management Program (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. The *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003) was issued on February 27, 2003 and requires SWMPs to include six minimum control measures:

- Public education and outreach on storm water impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site storm water runoff control
- Post-construction storm water management in new development and re-development
- Pollution prevention/good housekeeping for municipal operations

For discharges into impaired waters, the Phase II MS4 General Permit (ref: http://www.state.tn.us/environment/wpc/stormh2o/MS4II.php) requires that SWMPs include a section describing how discharges of pollutants of concern will be controlled to ensure that they do not cause or contribute to instream exceedances of water quality standards. Specific measures and

BMPs to control pollutants of concern must also be identified. In addition, MS4s must implement the WLA provisions of an applicable TMDL and <u>describe methods to evaluate whether storm water controls are adequate to meet the WLA</u>.

In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs. Instream monitoring, at locations selected to best represent the effectiveness of BMPs, must include analytical monitoring of pollutants of concern. A detailed plan describing the monitoring program must be submitted to the Division of Water Pollution Control Nashville Field Office within 12 months of the approval date of this TMDL. Implementation of the monitoring program must commence within 6 months of plan approval by the Field Office. The monitoring program shall comply with the monitoring, recordkeeping, and reporting requirements of NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems (TDEC, 2003).

9.1.3 NPDES Regulated Concentrated Animal Feeding Operations (CAFOs)

As of May 11, 2005, there are no Class I or Class II CAFOs in the Harpeth River watershed with coverage under the general NPDES permit. WLAs and implementation requirements are provided for any future facilities.

WLAs provided to CAFOs will be implemented through NPDES Permit No. TNA000000, General NPDES Permit for *Class II Concentrated Animal Feeding Operation* or the facility's individual permit. Among the provisions of the general permit are:

- Development and implementation of a site-specific Nutrient Management Plan (NMP) that:

    - Includes best management practices (BMPs) and procedures necessary to implement applicable limitations and standards;
    - Ensures adequate storage of manure, litter, and process wastewater including provisions to ensure proper operation and maintenance of the storage facilities.
    - Ensures proper management of mortalities (dead animals);
    - Ensures diversion of clean water, where appropriate, from production areas;
    - Identifies protocols for manure, litter, wastewater and soil testing;
    - Establishes protocols for land application of manure, litter, and wastewater;
    - Identifies required records and record maintenance procedures.

  The NMP must submitted to the State for approval and a copy kept on-site.

- Requirements regarding manure, litter, and wastewater land application BMPs.

- Requirements for the design, construction, operation, and maintenance of CAFO liquid waste management systems that are constructed, modified, repaired, or placed into operation after April 13, 2006. The final design plans and specifications for these systems must meet or exceed standards in the NRCS Field Office Technical Guide and other guidelines as accepted by the Departments of Environment and Conservation, or Agriculture.

Provisions of individual CAFO permits are similar. NPDES Permit No. TNA000000, *Class II Concentrated Animal Feeding Operation General Permit* is available on the TDEC website at http://www.state.tn.us/environment/wpc/programs/cafo/CAFO_GP_04.pdf

9.2 Nonpoint Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most nonpoint source discharges. Reductions of pathogen loading from nonpoint sources (NPS) will be achieved using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired waters. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. There are links to a number of publications and information resources on EPA's Nonpoint Source Pollution web page (http://www.epa.gov/owow/nps/pubs.html) relating to the implementation and evaluation of nonpoint source pollution control measures.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref: http://www.state.tn.us/environment/wpc/watershed/). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. It relies on participation at the federal, state, local and nongovernmental levels to be successful.

Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. One local stakeholder group, Harpeth River Watershed Association (HRWA), is dedicated to preserving and restoring the ecological health of the Harpeth. Their work leverages the scientific and technical training and experience of their staff and advisors with the efforts of a diverse corps of volunteers. Details regarding activities of the HRWA are available at their web site (http://www.harpethriver.org).

The HRWA has recently received a three-year grant from the EPA that will enable them to focus on how local land use planning, stormwater regulations, and other municipal tools are most effective at achieving water quality goals and reducing pollutants going into the Harpeth River. The HRWA will organize an integrated approach to meeting pollutant reductions and protecting the Harpeth and drinking water sources. The project will concentrate on Five Mile Creek, which is in the I-65 corridor and is identified as a new "growth area" in the Franklin land use plan. Five Mile Creek provides source waters for Franklin's drinking water supply. This area, which is currently agricultural, is well suited for environmental assessment before, during, and after development. A key outcome of this project is to provide materials, tools, and guidance that cities and counties around the state can use based on the results of the study in the Harpeth River watershed.

BMPs have been utilized in the Harpeth River Watershed to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. These BMPs (e.g., animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment, livestock exclusion, etc.) may have contributed to reductions in in-stream concentrations of coliform bacteria in the Harpeth River Watershed during the TMDL evaluation period. The TDA keeps a database of BMPs implemented in Tennessee. Those listed in the Harpeth River Watershed are

shown in Figure 11. It is recommended that additional information (e.g., livestock access to streams,
manure application practices, etc.) be provided and evaluated to better identify and quantify agricultural sources of coliform bacteria loading in order to minimize uncertainty in future modeling efforts.

It is further recommended that BMPs be utilized to reduce the amount of coliform bacteria transported to surface waters from agricultural sources. Demonstration sites for various types of BMPs should be established, maintained, and evaluated (performance in source reduction) over a period of at least two years prior to recommendations for utilization for subsequent implementation. E. coli sampling and monitoring are recommended during low-flow (baseflow) and storm periods at sites with and without BMPs and/or before and after implementation of BMPs.

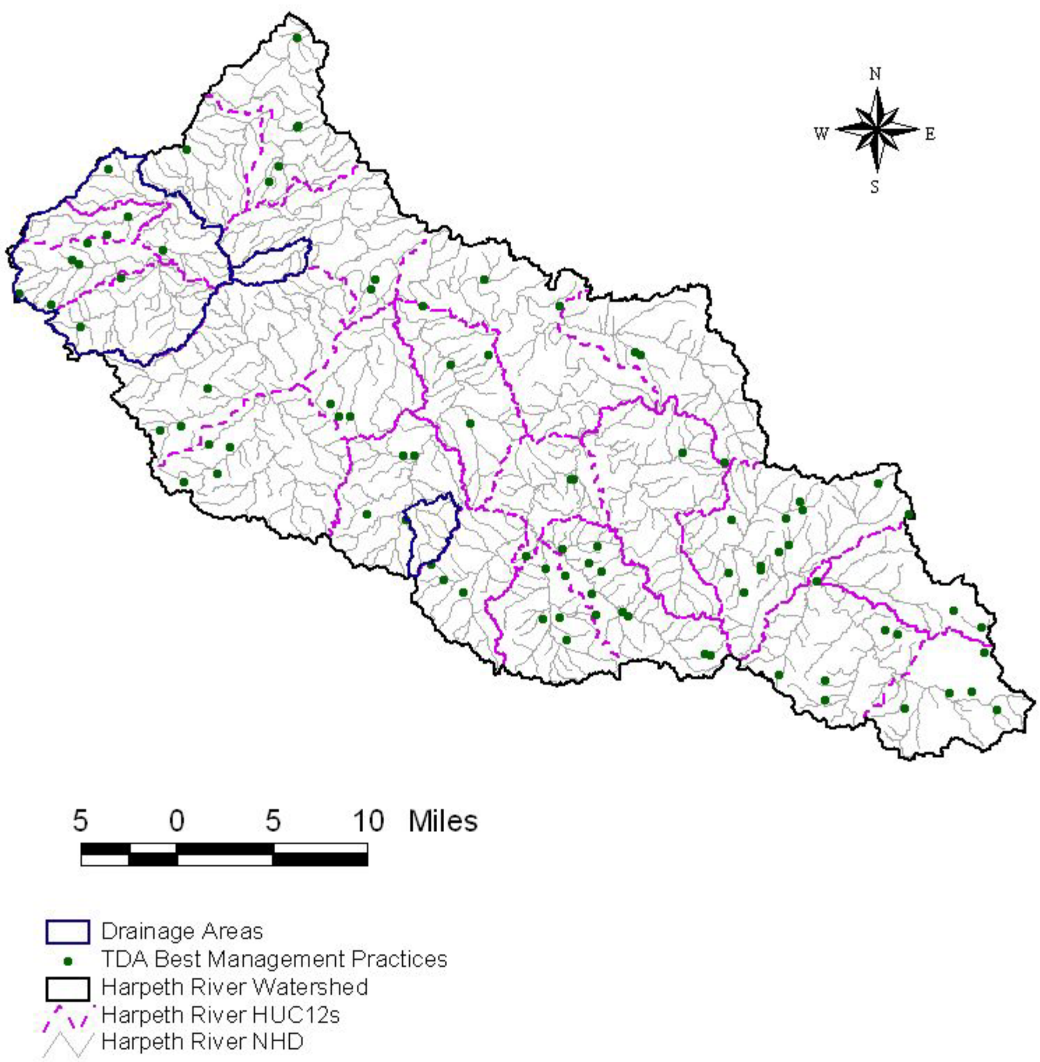

Figure 11. Tennessee Department of Agriculture Best Management Practices located in the Harpeth River Watershed.

9.3 Application of Load Duration Curves for Implementation Planning

The Load Duration Curve methodology (Appendix C) is a form of water quality analysis and presentation of data that aids in guiding implementation by targeting strategies to appropriate flow conditions. One of the strengths of this method is that it can be used to interpret possible delivery mechanisms of pathogens by differentiating between point and nonpoint problems. The E. coli load duration analysis was utilized for implementation planning. The E. coli load duration curve for each pathogen-impaired subwatershed (Figures C-2 through C-10) was analyzed to determine the frequency with which water quality monitoring data exceed the E. coli target maximum concentration of 941 CFU/100 mL under five flow conditions (low, dry, mid- range, moist, and high). A sample E. coli load duration curve is presented in Figure 12.

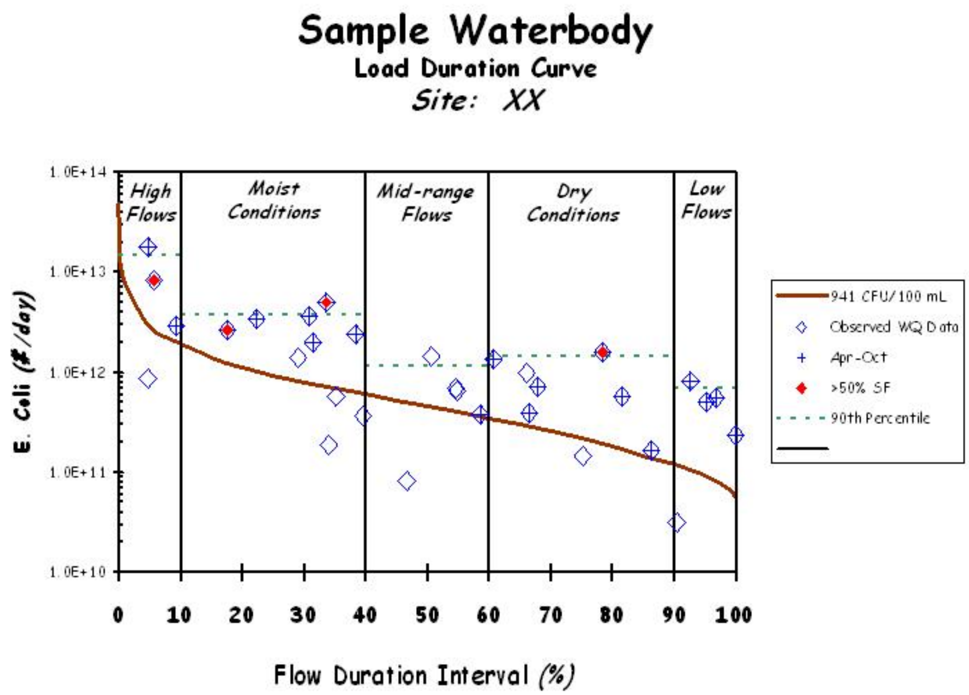

Figure 12. Sample E. Coli Load Duration Curve

Table 10 presents an example of Load Duration analysis statistics for E. coli. Table 11 presents targeted implementation strategies for each source category covering the entire range of flow (Stiles, 2003). Each implementation strategy addresses a range of flow conditions and targets point sources, nonpoint sources, or a combination of each. Results indicate the implementation strategy for all subwatersheds will require BMPs targeting a variety of sources. The implementation strategies listed in Table 10 are a subset of the categories of BMPs and implementation strategies available for application to the pathogen-impaired Harpeth River Watersheds for reduction of pathogen loading and mitigation of water quality impairment.

See Appendix C for a detailed discussion of the Load Duration Curve Methodology applied to the Harpeth River Watershed.

Table 10 Sample Load Duration Curve Summary

Flow Condition		High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded		0-10	10-40	40-60	60-90	90-100
Sample Site	% Samples > 941 CFU/100 mL	75.0	90.0	40.0	87.5	80.0
	Reduction	>61.1	>61.1	>49.7	>61.1	>61.1

Table 11 Example Implementation Strategies

Flow Condition	High	Moist	Mid-range	Dry	Low
% Time Flow Exceeded	0-10	10-40	40-60	60-90	90-100
Municipal NPDES		**L**	**M**	**H**	**H**
Stormwater Management		**H**	**H**	**H**	
SSO Mitigation	**H**	**H**	**M**	**L**	
Collection System Repair		**L**	**M**	**H**	**H**
Septic System Repair		**L**	**M**	**H**	**M**
Livestock Exclusion[1]			**M**	**H**	**H**
Pasture Management/Land Application of Manure[1]	**H**	**H**	**M**	**L**	
Riparian Buffers[1]		**H**	**H**	**H**	
Potential for source area contribution under given hydrologic condition (H: High; M: Medium; L: Low)					

[1] Example Best Management Practices (BMPs) for Agricultural Source reduction. Actual BMPs applied may vary.

9.4 Additional Monitoring

Documenting progress in reducing the quantity of pathogens entering the Harpeth River Watershed is an essential element of the TMDL Implementation Plan. Additional monitoring and assessment activities are recommended to determine whether implementation of TMDLs, WLAs, & LAs in tributaries and upstream reaches will result in achievement of instream water quality targets for E. coli. Future monitoring activities should be representative of all seasons and a full range of flow and meteorological conditions. Monitoring activities should also be adequate to assess water quality using the 30-day geometric mean standard.

Tennessee's watershed management approach specifies a five-year cycle for planning and assessment. Each watershed will be examined (or re-examined) on a rotating basis. Generally, in years two and three of the five-year cycle, water quality data are collected in support of water quality assessment (including TMDL development) and planning activities. Therefore, a watershed TMDL is developed one to two years prior to commencement of the next cycle's monitoring period.

Additional monitoring and assessment activities are recommended for all impaired waterbodies in the Harpeth River watershed. No monitoring data was available for West Prong Murfrees Fork and fewer than 10 samples were taken at any other location. Examination of monitoring data indicates that no sampling events have occurred during the summer (July, August, and September) and few sampling events have occurred during dry periods and period of low flow. Once additional monitoring representing all seasons and a full range of flow and meteorological conditions has been obtained, the required load reductions may be revised.

9.5 Source Identification

An important aspect of pathogen load reduction activities is the accurate identification of the actual sources of pollution. In cases where the sources of pathogen impairment are not readily apparent, Microbial Source Tracking (MST) is one approach to determining the sources of fecal pollution and pathogens affecting a waterbody. Those methods that use bacteria as target organisms are also known as Bacterial Source Tracking (BST) methods. This technology is recommended for source identification in pathogen impaired waterbodies.

Bacterial Source Tracking is a collective term used for various emerging biochemical, chemical, and molecular methods that have been developed to distinguish sources of human and non-human fecal pollution in environmental samples (Shah, 2004). In general, these methods rely on genotypic (also known as "genetic fingerprinting"), or phenotypic (relating to the physical characteristics of an organism) distinctions between the bacteria of different sources. Three primary genotypic techniques are available for BST: ribotyping, pulsed field gel electrophoresis (PFGE), and polymerase chain reaction (PCR). Phenotypic techniques generally involve an antibiotic resistance analysis (Hyer, 2004).

The USEPA has published a fact sheet that discusses BST methods and presents examples of BST application to TMDL development and implementation (USEPA, 2002b). Various BST projects and descriptions of the application of BST techniques used to guide implementation of effective BMPs to remove or reduce fecal contamination are presented. The fact sheet can be found on the following EPA website: http://www.epa.gov/owm/mtb/bacsortk.pdf.

A multi-disciplinary group of researchers is developing and testing a series of different microbial assay methods based on real-time PCR to detect fecal bacterial concentrations and host sources in water samples (McKay, 2005). The assays have been used in a study of fecal contamination and have proven useful in identification of areas where cattle represent a significant fecal input and in development of BMPs. It is expected that these types of assays could have broad applications in monitoring fecal impacts from Animal Feeding Operations, as well as from wildlife and human sources. Other BST projects have been conducted or are currently in progress throughout the state of Tennessee, as presented in sessions of the Thirteenth Tennessee Water Resources Symposium (Lawrence, 2003) and the Fifteenth Tennessee Water Resources Symposium (Bailey, 2005; Baldwin, 2005; Farmer, 2005).

9.6 Evaluation of TMDL Implementation Effectiveness

The effectiveness of the TMDL will be assessed within the context of the State's rotating watershed management approach. Watershed monitoring and assessment activities will provide information by which the effectiveness of pathogen loading reduction measures can be evaluated. Additional monitoring data, ground-truthing activities, and bacterial source identification actions are recommended to enable implementation of particular types of BMPs to be directed to specific areas in impaired subwatersheds. This will optimize utilization of resources to achieve maximum reductions in pathogen loading. These TMDLs will be re-evaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

10.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed E. coli TMDLs for the Harpeth River Watershed were placed on Public Notice for a 35-day period and comments solicited. Steps that were taken in this regard include:

1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website. The announcement invited public and stakeholder comment and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings which is sent to approximately 90 interested persons or groups who have requested this information.

3) Letters were sent to WWTFs located in E. coli-impaired subwatersheds or drainage areas in the Harpeth River Watershed, permitted to discharge treated effluent containing pathogens, advising them of the proposed TMDLs and their availability on the TDEC website. The letters also stated that a copy of the draft TMDL document would be provided on request. A letter was sent to the following facilities:

    Dickson STP (TN0066958)
    Eagleville High School (TN0057789)
    Franklin STP (TN0028827)
    Goose Creek Inn (TN0060216)
    Oakview Elementary School (TN0067873)
    White Bluff STP (TN0020460)

4) A draft copy of the proposed TMDL was sent to those MS4s that are wholly or partially located in pathogen-impaired subwatersheds. A draft copy was sent to the following entities:

    Metro Nashville/Davidson County (TNS068047)
    City of Brentwood, Tennessee (TNS075175)
    City of Dickson, Tennessee (TNS077542)
    City of Franklin, Tennessee (TNS075311)
    Rutherford County, Tennessee (TNS075647)
    Wiliamson County, Tennessee (TNS075795)
    Tennessee Dept. of Transportation (TNS077585)

5) A letter was sent to local stakeholder groups in the Harpeth River Watershed advising them of the proposed E. coli TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided upon request. A letter was sent to the following local stakeholder group:

    Harpeth River Watershed Association

11.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section
e-mail: Vicki.Steed@state.tn.us

Sherry H. Wang, Ph.D., Watershed Management Section
e-mail: Sherry.Wang@state.tn.us

REFERENCES

Bailey, F.C., Farmer, J.J., Ejiofor, A.O., and Johnson, T.L., 2005. *Use of Flow Duration Curves and Load Duration Curves to Enhance Fecal Bacterial Source Tracking in Stoners Creek, Davidson County, Tennessee*. In: Proceedings of The Fifteenth Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, Session 2B, Paper 4.

Baldwin, Trisha, Layton, Alice, McKay, Larry, Jones, Sid, Johnson, Greg, Fout, Shay, and Garret, Victoria, 2005. *Monitoring of Enterovirus and Hepatitis A Virus in Wells and Springs in East Tennessee*. In: Proceedings of The Fifteenth Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, Session 2B, Paper 6.

Farmer, J.J., Bailey, F.C., Ejiofor, A.O., and Johnson, T.L., 2005. *Comparison of Antibiotic Resistance Patterns, Carbon Utilization Profiles, and Pulsed-field Gel Electrophoresis of Eschericia Coli for Fecal Bacterial Source Tracking in the Duck River, Middle Tennessee*. In: Proceedings of The Fifteenth Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, Session 2B, Paper 5.

Hyer, Kenneth E., and Douglas L. Moyer, 2004. *Enhancing Fecal Coliform Total Maximum Daily Load Models Through Bacterial Source Tracking*. Journal of the American Water Resources Association (JAWRA) 40(6):1511-1526. Paper No. 03180.

Lawrence, Tom, 2003. *Getting to the Source, Microbial Source Tracking in an Urban Stream*. In: Proceedings of the Thirteenth Tennessee Water Resources Symposium, Montgomery Bell State Park, Tennessee, Session 2B, Paper 3.

Lumb, A.M., McCammon, R.B., and Kittle, J.L., Jr., 1994, Users Manual for an expert system, (HSPFEXP) for calibration of the Hydrologic Simulation Program –Fortran: U.S. Geological Survey Water-Resources Investigation Report 94-4168,102 p.

McKay, Larry, Layton, Alice, and Gentry, Randy, 2005. *Development and Testing of Real-Time PCR Assays for Determining Fecal Loading and Source Identification (Cattle, Human, etc.) in Streams and Groundwater.* This document is available on the UTK website: http://web.utk.edu/~hydro/Research/McKayAGU2004abstract.pdf .

NCSU. 1994. *Livestock Manure Production and Characterization in North Carolina*, North Carolina Cooperative Extension Service, North Carolina State University (NCSU) College of Agriculture and Life Sciences, Raleigh, January 1994.

Shah, Vikas G., Hugh Dunstan, and Phillip M. Geary, 2004. *Application of Emerging Bacterial Source Tracking (BST) Methods to Detect and Distinguish Sources of Fecal Pollution in Waters.* School of Environmental and Life Sciences, The University of Newcastle, Callaghan, NSW 2308 Australia. This document is available on the University of Newcastle website: http://www.newcastle.edu.au/discipline/geology/staff_pg/pgeary/BacterialSourceTracking.pdf.

Stiles, T., and B. Cleland, 2003, Using Duration Curves in TMDL Development & Implementation Planning. ASIWPCA "States Helping States" Conference Call, July 1, 2003. This document is available on the Indiana Office of Water Quality website: http://www.in.gov/idem/water/planbr/wqs/tmdl/durationcurveshscall.pdf .

TDEC. 1999. *State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, October 1999.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control.

TDEC. 2003. *General Permit for Discharges from Small Municipal Separate Storm Sewer Systems.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, February 2003. This document is available on the TDEC website: http://www.state.tn.us/environment/wpc/stormh2o/MS4II.htm.

TDEC. 2004a. *Final 2004 303(d) List*. State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control, August 2005.

TDEC. 2004b. *State of Tennessee Water Quality Standards, Chapter 1200-4-3 General Water Quality Criteria, January 2004.* State of Tennessee, Department of Environment and Conservation, Division of Water Pollution Control.

USEPA. 1991. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

USEPA. 1997. *Ecoregions of Tennessee*. U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Corvallis, Oregon. EPA/600/R-97/022.

USEPA, 2002a. *Animal Feeding Operations Frequently Asked Questions*. USEPA website URL: http://cfpub.epa.gov/npdes/faqs.cfm?program_id=7 . September 12, 2002.

USEPA, 2002b. *Wastewater Technology Fact Sheet, Bacterial Source Tracking*. U.S. Environmental Protection Agency, Office of Water. Washington, D.C. EPA 832-F-02-010, May 2002. This document is available on the EPA website: http://www.epa.gov/owm/mtb/bacsortk.pdf.

APPENDIX A

Land Use Distribution in the Harpeth River Watershed

Table A-1. MRLC Land Use Distribution of Harpeth River Subwatersheds

Land Use	HUC-12 Subwatershed (05130204__) or Drainage Area					
	0101		0105		0201	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Deciduous Forest	7362.6	32.5	7,431.4	22.3	5,544.8	24.0
Emergent Herbaceous Wetlands	0.0	0.0	0.0	0.0	0.0	0.0
Evergreen Forest	1,452.0	6.4	1,047.5	3.1	493.7	2.1
High Intensity Commercial/Industrial/Transp.	62.7	0.3	1,342.4	4.0	106.5	0.5
High Intensity Residential	4.9	0.0	405.9	1.2	0.0	0.0
Low Intensity Residential	181.9	0.8	2,521.3	7.6	86.3	0.4
Mixed Forest	3,428.2	15.1	4,557.6	13.7	2,713.5	11.8
Open Water	6.4	0.0	218.8	0.7	41.6	0.2
Other Grasses (Urban/recreation; e.g. parks)	115.4	0.5	2,541.8	7.6	83.4	0.4
Pasture/Hay	5,790.1	25.6	8,354.7	25.1	10,926.1	47.4
Quarries/Strip Mines/Gravel Pits	0.0	0.0	140.8	0.4	0.0	0.0
Row Crops	4,118.3	18.2	4,681.4	14.0	3,037.3	13.2
Transitional	109.0	0.5	53.2	0.2	40.5	0.2
Woody Wetlands	0.0	0.0	24.5	0.1	0.0	0.0
Total	22,631.7	100.0	33,321.1	100.0	23,073.6	100.0

Note: Percent calculations were performed using a spreadsheet. Percentages and totals were rounded off and may differ slightly from values calculated by other means.

Table A-1 (Cont.). MRLC Land Use Distribution of Harpeth River Subwatersheds

Land Use	HUC-12 Subwatershed (05130204__) or Drainage Area					
	0202		0302		Trace Creek DA	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Deciduous Forest	7,079.7	37.5	9,186.9	30.7	3,220.5	87.3
Emergent Herbaceous Wetlands	0.0	0.0	0.0	0.0	0.0	0.0
Evergreen Forest	246.4	1.3	1,682.2	5.6	22.9	0.6
High Intensity Commercial/Industrial/Transp.	19.3	0.1	755.0	2.5	37.6	1.0
High Intensity Residential	3.3	0.0	80.5	0.3	6.9	0.2
Low Intensity Residential	91.6	0.5	2,068.7	6.9	72.9	2.0
Mixed Forest	1,723.8	9.1	6,317.4	21.1	104.3	2.8
Open Water	11.6	0.1	78.7	0.3	0.0	0.0
Other Grasses (Urban/recreation; e.g. parks)	79.6	0.4	2,024.7	6.8	40.0	1.1
Pasture/Hay	7,755.2	41.1	6,129.9	20.5	108.5	2.9
Quarries/Strip Mines/Gravel Pits	0.0	0.0	0.0	0.0	0.0	0.0
Row Crops	1,869.0	9.9	1,641.1	5.5	73.4	2.0
Transitional	0.0	0.0	0.0	0.0	3.8	0.1
Woody Wetlands	0.0	0.0	0.0	0.0	0.0	0.0
Total	18,879.6	100.0	29,965.2	100.0	3,690.9	100.0

Note: Percent calculations were performed using a spreadsheet. Percentages and totals were rounded off and may differ slightly from values calculated by other means.

Table A-1 (Cont.). MRLC Land Use Distribution of Harpeth River Subwatersheds

Land Use	HUC-12 Subwatershed (05130204__) or Drainage Area					
	Arkansas Creek DA		0601		Jones Creek DA (in 0604)	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Deciduous Forest	4,175.5	91.3	7,893.5	42.2	9,202.5	65.0
Emergent Herbaceous Wetlands	0.0	0.0	0.0	0.0	0.0	0.0
Evergreen Forest	8.7	0.2	510.6	2.7	234.4	1.7
High Intensity Commercial/Industrial/Transp.	1.1	0.0	589.6	3.2	76.3	0.5
High Intensity Residential	0.0	0.0	212.6	1.1	8.7	0.1
Low Intensity Residential	4.0	0.1	830.2	4.4	151.5	1.1
Mixed Forest	57.4	1.3	1,383.5	7.4	920.7	6.5
Open Water	1.6	0.0	88.3	0.5	2.9	0.0
Other Grasses (Urban/recreation; e.g. parks)	0.0	0.0	411.2	2.2	115.4	0.8
Pasture/Hay	190.8	4.2	4,327.8	23.1	2,121.7	15.0
Quarries/Strip Mines/Gravel Pits	0.0	0.0	96.5	0.5	0.0	0.0
Row Crops	131.4	2.9	2,361.6	12.6	1,325.9	9.4
Transitional	0.4	0.0	7.1	0.0	0.0	0.0
Woody Wetlands	0.0	0.0	0.0	0.0	5.3	0.0
Total	4,570.9	100.0	18,712.6	100.0	14,165.3	100.0

Note: Percent calculations were performed using a spreadsheet. Percentages and totals were rounded off and may differ slightly from values calculated by other means.

APPENDIX B

Water Quality Monitoring Data

There are a number of water quality monitoring stations that provide data for waterbodies identified as impaired for E. coli in the Harpeth River Watershed. The location of these monitoring stations is shown in Figure 5. Monitoring data recorded by TDEC at these stations are tabulated in Table B-1.

Table B-1. TDEC Water Quality Monitoring Data – Harpeth River Subwatersheds

Monitoring Station	Date	E. Coli
		[cts./100 mL]
ARKAN000.1WI	10/10/01	>2400
	11/29/01	>2400
	12/15/01	920
	12/18/01	980
	1/22/02	580
	2/26/02	1100
	3/26/02	920
	4/5/02	100
	4/8/02	110
	5/6/02	520
	6/25/02	>2400
FIVEM001.4WI	10/10/01	820
	11/29/01	>2400
	12/18/01	490
	1/22/02	1700
	2/28/02	730
	3/27/02	1300
	4/11/02	1300
	5/15/02	2000
	6/4/02	>2400
HARPE079.8WI	10/10/01	170
	11/29/01	>2400
	12/18/01	460
	1/22/02	110
	2/28/02	37
	3/27/02	>2400
	4/11/02	120
	5/15/02	1700
	6/4/02	160

Monitoring Station	Date	E. Coli [cts./100 mL]
HARPE092.4WI	10/10/01	180
	11/29/01	>2400
	12/18/01	410
	1/22/02	160
	2/28/02	45
	3/27/02	>2400
	4/11/02	230
	5/15/02	1400
	6/4/02	190
JONES010.1DI	11/13/01	210
	12/5/01	150
	1/8/02	19
	2/19/02	59
	3/27/02	110
	4/25/02	610
	5/14/02	690
	6/12/02	110
JONES019.6DI	11/13/01	>2400
	12/5/01	1200
	2/19/02	370
	3/27/02	1700
	4/25/02	>2400
	5/14/02	520
	6/12/02	>2400
KELLE000.4RU	10/9/01	1600
	11/8/01	>2400
	12/12/01	210
	1/29/02	160
	2/21/02	150
	3/18/02	>2400
	4/10/02	25
	5/23/02	920
	6/11/02	440

Monitoring Station	Date	E. Coli [cts./100 mL]
LHARP001.0WI	10/18/01	130
	11/20/01	83
	12/13/01	1100
	1/23/02	>2400
	2/28/02	10
	4/11/02	110
	5/15/02	980
	6/4/02	170
LJONE000.8DI	11/13/01	32
	12/5/01	180
	2/19/02	52
	3/27/02	170
	4/25/02	460
	5/14/02	490
	6/12/02	340
MURFR003.9WI	10/10/01	1700
	11/29/01	>2400
	12/18/01	730
	1/22/02	490
	2/26/02	610
	3/26/02	>2400
	4/8/02	870
	5/6/02	2000
	6/25/02	1600
TOWNB003.4DI	11/13/01	40
	12/5/01	1300
	2/19/02	210
	3/27/02	150
	4/25/02	820
	5/14/02	520
	6/12/02	1300

Monitoring Station	Date	E. Coli [cts./100 mL]
TRACE003.5DI	11/13/01	83
	12/5/01	580
	1/8/02	>2400
	2/19/02	200
	3/27/02	>2400
	4/25/02	1100
	5/14/02	>2400
	6/12/02	1300
WHARP000.3WI	10/10/01	57
	11/29/01	>2400
	12/18/01	730
	1/22/02	100
	2/26/02	110
	3/26/02	>2400
	4/5/02	120
	5/6/02	770
	6/25/02	340
WHARP017.7WI	10/10/01	410
	11/29/01	>2400
	12/18/01	650
	1/22/02	290
	2/26/02	920
	3/26/02	>2400
	4/8/02	820
	5/6/02	1200
	6/25/02	800

APPENDIX C

Development of TMDLs, WLAs, & LAs

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), nonpoint source loads (Load Allocations), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma\ \text{WLAs} + \Sigma\ \text{LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

C.1 Development of TMDLs

E. coli TMDLs, WLAs, and LAs were developed for impaired subwatersheds and drainage areas in the Harpeth River Watershed using Load Duration Curves (LDCs) to determine the reduction in pollutant loading required to decrease existing, instream E. coli concentrations to target levels. TMDLs are expressed as required percent reductions in pollutant loading.

C.1.1 Development of Flow Duration Curves

A flow duration curve is a cumulative frequency graph, constructed from historic flow data at a particular location, that represents the percentage of time a particular flow rate is equaled or exceeded. Flow duration curves are developed for a waterbody from daily discharges of flow over a period of record. In general, there is a higher level of confidence that curves derived from data over a long period of record correctly represent the entire range of flow. The preferred method of flow duration curve computation uses daily mean data from USGS continuous-record stations located on the waterbody of interest. For ungaged streams, alternative methods must be used to estimate daily mean flow. These include: 1) regression equations (using drainage area as the independent variable) developed from continuous record stations in the same ecoregion; 2) drainage area extrapolation of data from a nearby continuous-record station of similar size and topography; and 3) calculation of daily mean flow using a dynamic computer model, such as the Loading Simulation Program C++ (LSPC).

Flow duration curves for impaired waterbodies in the Harpeth River Watershed were derived from LSPC hydrologic simulations based on parameters derived from calibration at USGS Station No. 03433500, located on Harpeth River at Belleview, in the Harpeth River watershed (see Appendix D for details of calibration). For example, a flow-duration curve for Trace Creek at RM 3.5 was constructed using simulated daily mean flow for the period from 10/1/94 through 9/31/04 (RM 3.5 corresponds to the location of monitoring station TRACE003.5DI). This flow duration curve is shown in Figure C-1 and represents the cumulative distribution of daily discharges arranged to show percentage of time specific flows were exceeded during the period of record (the highest daily mean flow during this period is exceeded 0% of the time and the lowest daily mean flow is equaled or exceeded 100% of the time). Flow duration curves for other impaired waterbodies were derived using a similar procedure.

C.1.2 Development of Load Duration Curves and Determination of TMDLs

When a water quality target concentration is applied to the flow duration curve, the resulting load duration curve (LDC) represents the allowable pollutant loading in a waterbody over the entire range of flow. Pollutant monitoring data, plotted on the LDC, provides a visual depiction of stream water quality as well as the frequency and magnitude of any exceedances. Load duration curve intervals can be grouped into several broad categories or zones, in order to provide additional insight about conditions and patterns associated with the impairment. For example, the duration curve could be divided into five zones: high flows (exceeded 0-10% of the time), moist conditions (10-40%), median or mid-range flows (40-60%), dry conditions (60-90%), and low flows (90-100%). Impairments observed in the low flow zone typically indicate the influence of point sources, while those further left on the LDC (representing zones of higher flow) generally reflect potential nonpoint source contributions (Stiles, 2003).

E. coli load duration curves for impaired waterbodies in the Harpeth River Watershed were developed from the flow duration curves developed in Section C.1.1, E. coli target concentrations, and available water quality monitoring data. Load duration curves and required load reductions were developed using the following procedure (Trace Creek is shown as an example):

1. A target load-duration curve (LDC) was generated for Trace Creek by applying the E. coli target concentration of 941 CFU/100 mL to each of the ranked flows used to generate the flow duration curve (ref.: Section D.1) and plotting the results. The E. coli target maximum load corresponding to each ranked daily mean flow is:

   $(\text{Target Load})_{\text{Trace Creek}}$ = (941 CFU/100 mL) x (Q) x (UCF)

   where: Q = daily mean flow
   UCF = the required unit conversion factor

2. Daily loads were calculated for each of the water quality samples collected at monitoring station TRACE003.5DI (ref.: Table B-1) by multiplying the sample concentration by the daily mean flow for the sampling date and the required unit conversion factor. TRACE003.5DI was selected for LDC analysis because it was the monitoring station on Trace Creek with the most exceedances of the target concentration.

   Note: *In order to be consistent for all analyses, the derived daily mean flow was used to compute sampling data loads, even if measured ("instantaneous") flow data was available for some sampling dates.*

   Example – 4/25/02 sampling event:
   Modelled Flow = 4.33 cfs
   Concentration = 1100 CFU/100 mL
   Daily Load = 1.17×10^{11} CFU/day

3. Using the flow duration curves developed in C.1.1, the "percent of days the flow was exceeded" (PDFE) was determined for each sampling event. Each sample load was then plotted on the load duration curves developed in Step 1 according to the PDFE. The resulting E. coli load duration curve for is shown in Figure C-2.

4. For cases where the existing load exceeded the target maximum load at a particular PDFE, the reduction required to reduce the sample load to the target load was calculated.

   Example – 4/25/02 sampling event:
   Target Concentration = 941 CFU/100 mL
   Measured Concentration = 1100 CFU/100 mL
   Reduction to Target = 14.5%

5. The 90th percentile value for all of the E. coli sampling data at TRACE003.5DI monitoring site was determined. If the 90th percentile value exceeded the target maximum E. coli concentration, the reduction required to reduce the 90th percentile value to the target maximum concentration was calculated (Table C-1).

   Example: Target Concentration = 941 CFU/100 mL
   90th Percentile Concentration = >2400 CFU/100 mL
   Reduction to Target = >60.8%

6. For cases where five or more samples were collected over a period of not more than 30 consecutive days, the geometric mean E. coli concentration was determined and compared to the target geometric mean E. coli concentration of 126 CFU/100 mL. If the sample geometric mean exceeded the target geometric mean concentration, the reduction required to reduce the sample geometric mean value to the target geometric mean concentration was calculated.

   Example: Insufficient monitoring data was available for any monitoring station in the Harpeth River watershed

7. The load reductions required to meet the target maximum (Step 5) and target 30-day geometric mean concentrations (Step 6) of E. coli were compared and the load reduction of the greatest magnitude selected as the TMDL for Trace Creek.

Load duration curves, required load reductions, and TMDLs of other impaired waterbodies were derived in a similar manner and are shown in Figures C-3 through C-10 and Tables C-2 through C-9.

C.2 Development of WLAs & LAs

As previously discussed, a TMDL can be expressed as the sum of all point source loads (WLAs), nonpoint source loads (LAs), and an appropriate margin of safety (MOS) that takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

Expanding the terms:

$$TMDL = [\Sigma WLAs]_{WWTF} + [\Sigma WLAs]_{MS4} + [\Sigma WLAs]_{CAFO} + [\Sigma LAs]_{DS} + [\Sigma LAs]_{SW} + MOS$$

For pathogen TMDLs in each impaired subwatershed or drainage area, WLA terms include:

- $[\Sigma WLAs]_{WWTF}$ is the allowable load associated with discharges of NPDES permitted WWTFs located in impaired subwatersheds or drainage areas. Since NPDES permits for these facilities specify that treated wastewater must meet instream water quality standards at the point of discharge, no additional load reduction is required. WLAs for WWTFs are calculated from the facility design flow and the Monthly Average permit limit.
- $[\Sigma WLAs]_{CAFO}$ is the allowable load for all CAFOs in an impaired subwatershed or drainage area. All wastewater discharges from a CAFO to waters of the state of Tennessee are prohibited, except when either chronic or catastrophic rainfall events cause an overflow of process wastewater from a facility properly designed, constructed, maintained, and operated to contain:
    - All process wastewater resulting from the operation of the CAFO (such as wash water, parlor water, watering system overflow, etc.); plus,
    - All runoff from a 25-year, 24-hour rainfall event for the existing CAFO or new dairy or cattle CAFOs; or all runoff from a 100-year, 24-hour rainfall event for a new swine or poultry CAFO.

  Therefore, a WLA of zero has been assigned to this class of facilities.
- $[\Sigma WLAs]_{MS4}$ is the required load reduction for discharges from MS4s. E. coli loading from MS4s is the result of buildup/wash-off processes associated with storm events.

LA terms include:

- $[\Sigma LAs]_{DS}$ is the allowable E. coli load from "other direct sources". These sources include leaking septic systems, leaking collection systems, illicit discharges, and animals access to streams. The LA specified for all sources of this type is zero CFU/day (or to the maximum extent practicable).
- $[\Sigma LAs]_{SW}$ represents the required reduction in E. coli loading from nonpoint sources indirectly going to surface waters from all land use areas (except areas covered by a MS4 permit) as a result of the buildup/wash-off processes associated with storm events.

Since WWTFs discharges must comply with instream water quality criteria (TMDL target) at the point of discharge, $[\sum WLAs]_{CAFO} = 0$, and $[\sum LAs]_{DS} = 0$, the expression relating TMDLs to precipitation-based point and nonpoint sources may be simplified to:

$$TMDL - MOS = [\sum WLAs]_{MS4} + [\sum LAs]_{SW}$$

WLAs for MS4s and LAs for precipitation-based nonpoint sources are equal and expressed as the percent reduction in loading required to decrease instream E. coli concentrations to TMDL target values minus MOS. As stated in Section 8.4, an explicit MOS, equal to 10% of the E. coli water quality targets (ref.: Section 5.0), was utilized for determination of the WLAs and LAs:

Instantaneous Maximum:	Target – MOS = (941 CFU/100 ml) – 0.1(941 CFU/100 ml)
	Target – MOS = 847 CFU/100 ml
30-Day Geometric Mean:	Target – MOS = (126 CFU/100 ml) – 0.1(126 CFU/100 ml)
	Target – MOS = 113 CFU/100 ml

C.2.1 Determination of WLAs for MS4s & LAs for Precipitation-Based Nonpoint Sources

WLAs for MS4s and LAs for precipitation-based nonpoint sources were developed using methods similar to those described in C.1.2 (again, using Trace Creek as an example):

8. An allocation LDC was generated for Trace Creek by applying the E. coli "target – MOS" concentration of 847 CFU/100 mL to each of the ranked flows used to generate the flow duration curve (ref.: Section D.1) and plotting the results on the target LDC developed in Step 1. The E. coli target maximum allocated load corresponding to each ranked daily mean flow is:

   $(\text{Target Load - MOS})_{\text{Trace Creek}} = (847\ \text{CFU/100 mL}) \times (Q) \times (UCF)$

   where: Q = daily mean flow
   UCF = the required unit conversion factor

9. For cases where the existing load exceeded the "target maximum load – MOS" at a particular PDFE, the reduction required to reduce the sample load to the "target – MOS" load was calculated.

   Example – 4/25/02 sampling event:
   Target Concentration -- MOS = 847 CFU/100 mL
   Measured Concentration = 1100 CFU/100 mL
   Reduction to Target -- MOS = 23.0%

10. If the 90th percentile value for all of the E. coli sampling data at TRACE003.5DI monitoring site (calculated in Step 5) exceeded the "target maximum – MOS" E. coli concentration, the reduction required to reduce the 90th percentile value to the "target maximum – MOS" concentration was calculated (Table C-1).

   Example: *Target Concentration -- MOS = 847 CFU/100 mL*

90^{th} Percentile Concentration = >2400 CFU/100 mL
Reduction to Target -- MOS = >64.7%

11. For cases where five or more samples were collected over a period of not more than 30 consecutive days, the geometric mean E. coli concentration was determined and compared to the “target geometric mean E. coli concentration – MOS” of 113 CFU/100 mL. If the sample geometric mean exceeded the “target geometric mean – MOS” concentration, the reduction required to reduce the sample geometric mean value to the “target geometric mean – MOS” concentration was calculated.

    Example: *Insufficient monitoring data was available for any monitoring station in the Harpeth River watershed*

12. The load reductions required to meet the “target maximum – MOS” (Step 10) and “target 30-day geometric mean – MOS” concentrations (Step 11) of E. coli were compared and the load reduction of the greatest magnitude selected as the WLA for MS4s and/or LA for precipitation-based nonpoint sources for Trace Creek.

Load duration curves, required load reductions, WLAs for MS4s, and LAs for precipitation-based nonpoint sources of other impaired waterbodies were derived in a similar manner and are shown in Figures C-3 through C-10 and Tables C-2 through C-9. TMDLs, WLAs, & LAs for impaired subwatersheds and drainage areas in the Harpeth River Watershed are summarized in Table C-10.

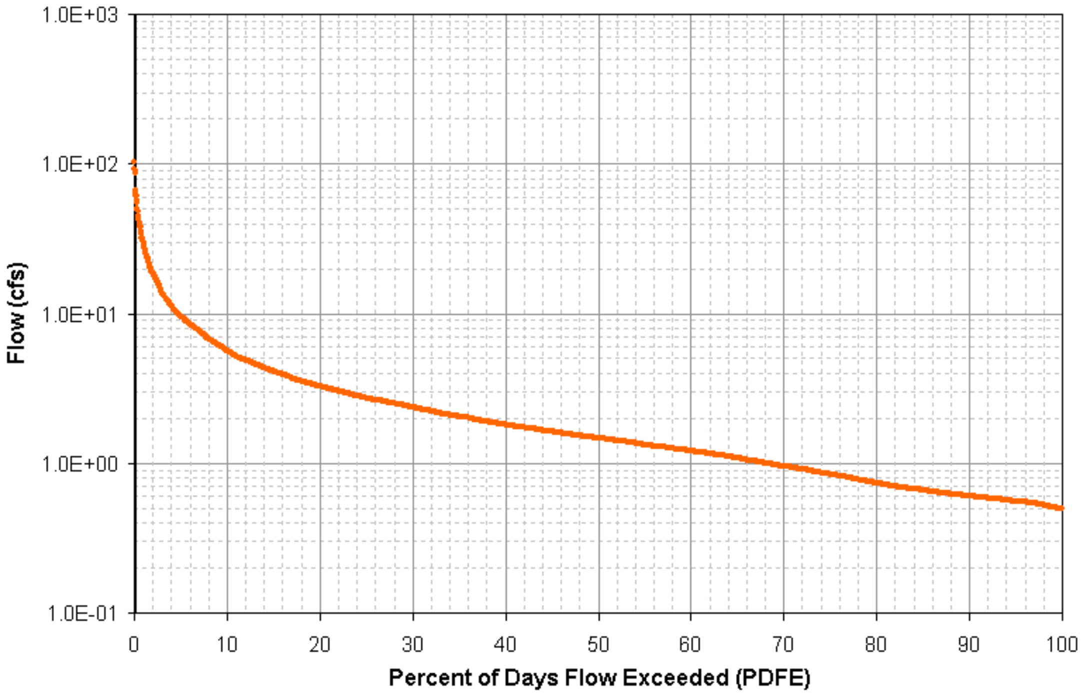

Figure C-1 Flow Duration Curve for Trace Creek at TRACE003.5DI

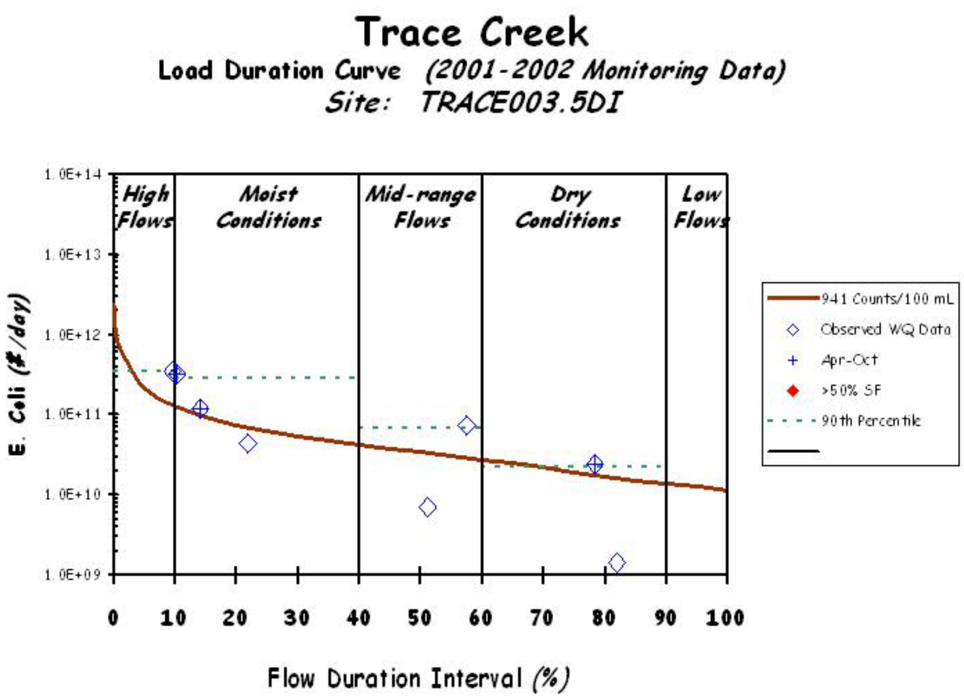

Figure C-2 E. Coli Load Duration Curve for Trace Creek at TRACE003.5DI

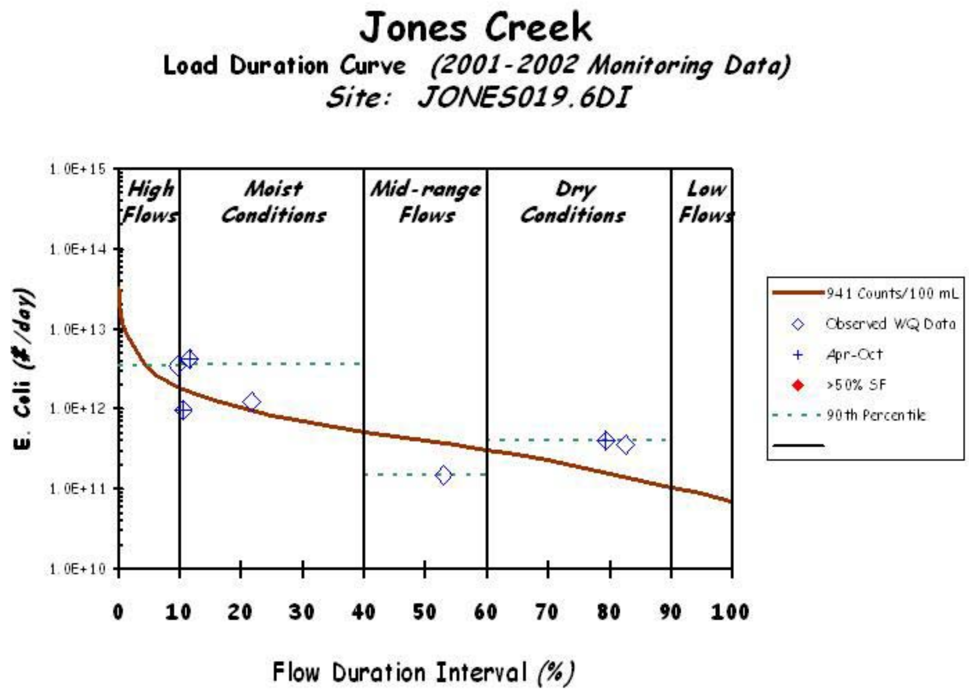

Figure C-3 E. Coli Load Duration Curve for Jones Creek at JONES019.6DI

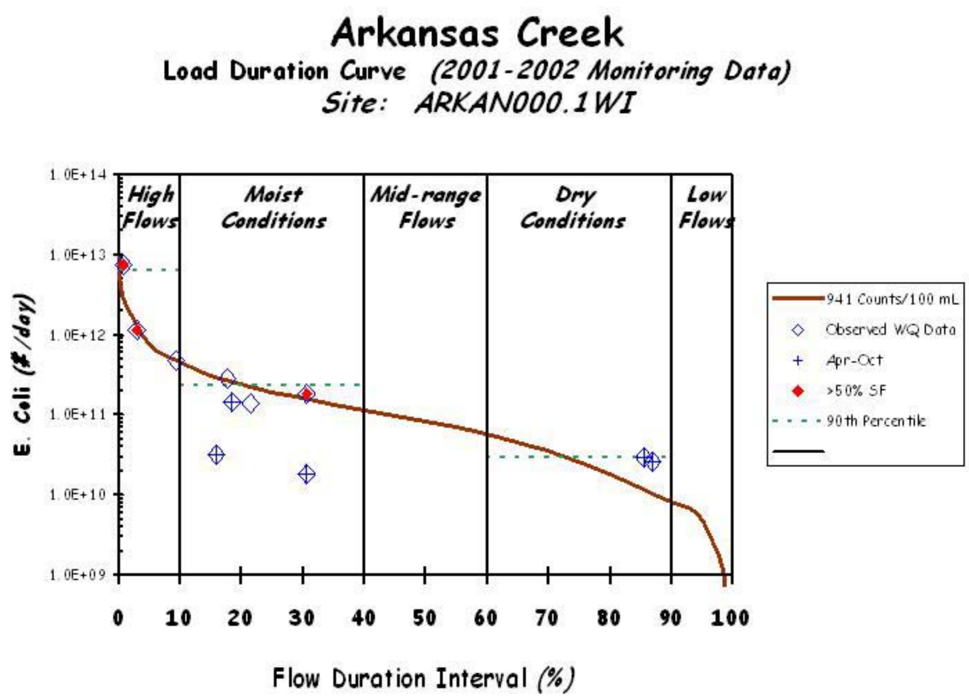

Figure C-4 E. Coli Load Duration Curve for Arkansas Creek at ARKAN000.1WI

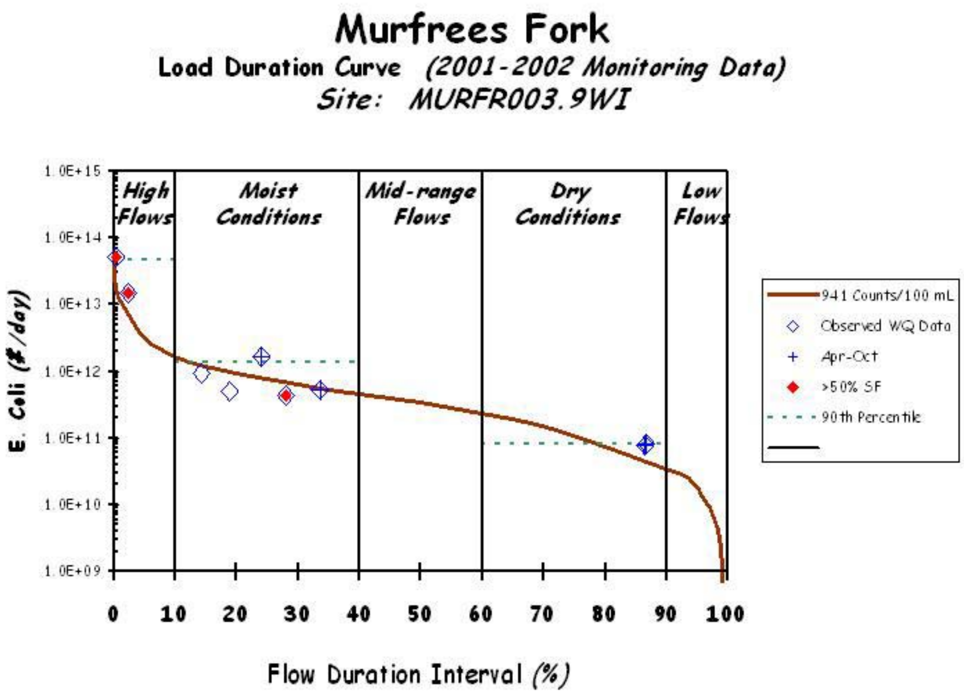

Figure C-5 E. Coli Load Duration Curve for Murfrees Fork at MURFR003.9WI

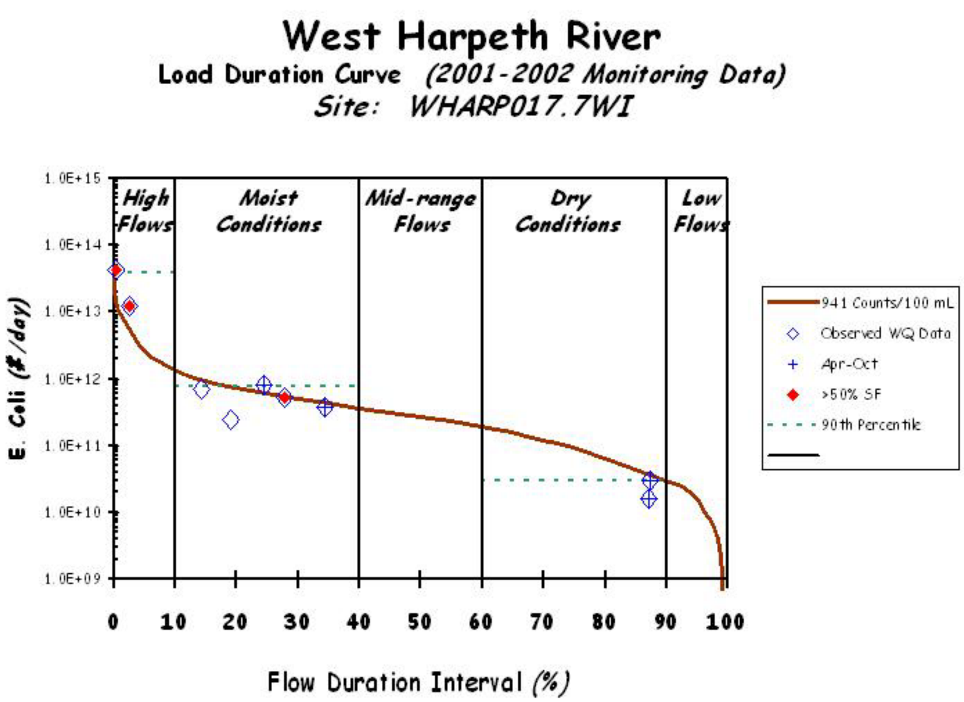

Figure C-6 E. Coli Load Duration Curve for West Harpeth River at WHARP017.7WI

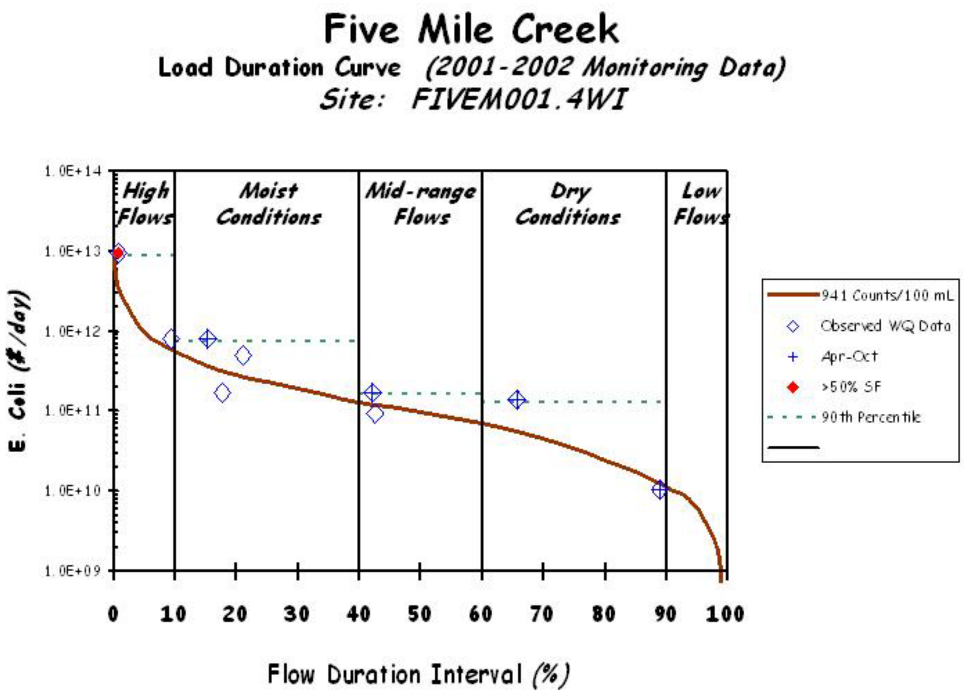

Figure C-7 E. Coli Load Duration Curve for Five Mile Creek at FIVEM001.4WI

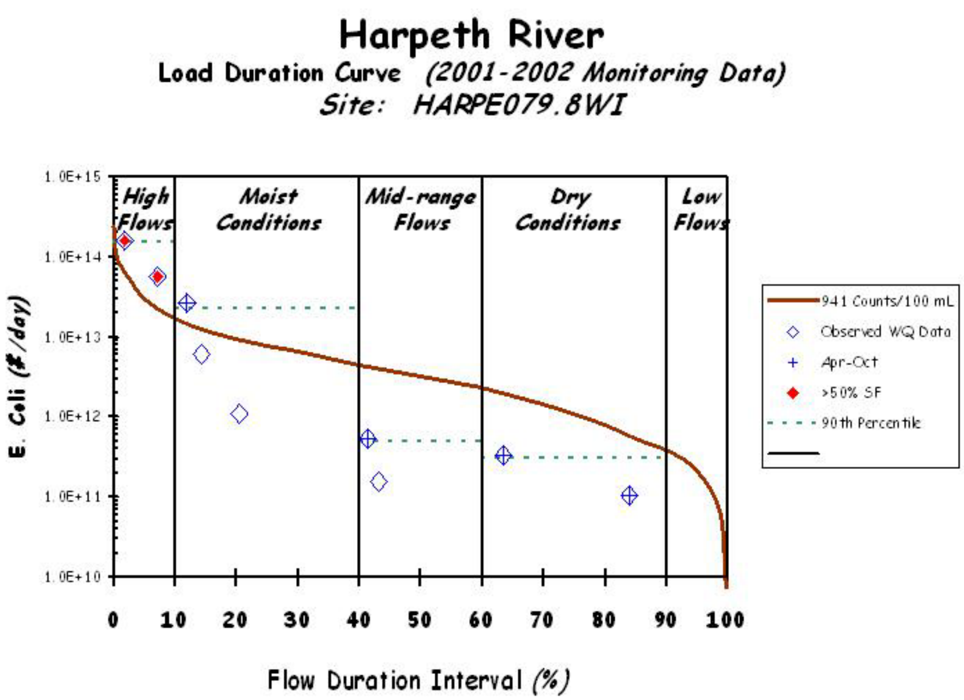

Figure C-8 E. Coli Load Duration Curve for Harpeth River at HARPE079.8WI

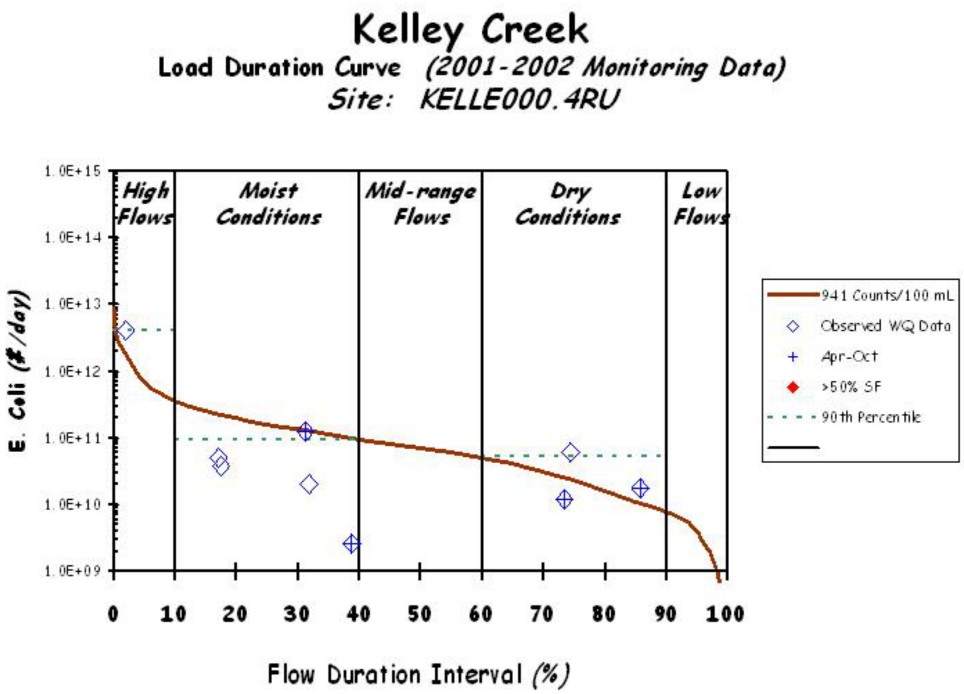

Figure C-9 E. Coli Load Duration Curve for Kelley Creek at KELLE000.4RU

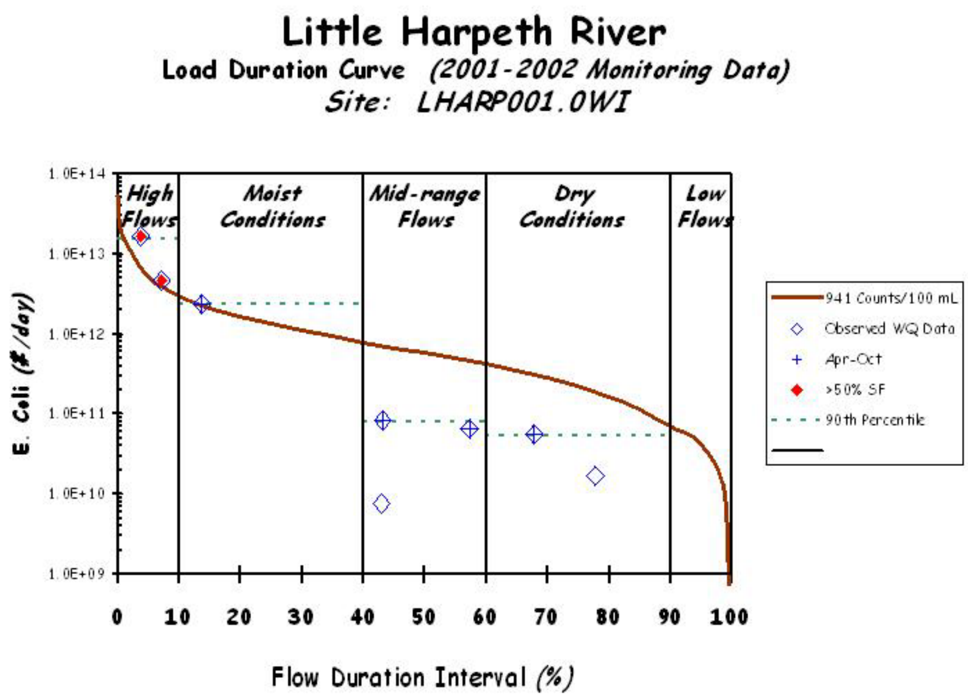

Figure C-10 E. Coli Load Duration Curve for Little Harpeth River at LHARP001.0WI

Table C-1 Required Load Reduction for Trace Creek at TRACE003.5DI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction: Sample to Target (941 CFU/100 ml)	Required Reduction: Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
11/13/01	0.70	82.0%	83	NR	NR
12/5/01	3.05	22.0%	580	NR	NR
1/8/02	1.27	57.5%	>2400	>60.8	>64.7
2/19/02	1.44	51.2%	200	NR	NR
3/27/02	5.98	9.5%	>2400	>60.8	>64.7
4/25/02	4.33	14.2%	1100	14.5	23.0
5/14/02	5.48	10.4%	>2400	>60.8	>64.7
6/12/02	0.77	78.4%	1300	27.6	34.8
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-2 Required Load Reduction for Jones Creek at JONES019.6DI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction: Sample to Target (941 CFU/100 ml)	Required Reduction: Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
11/13/01	6.04	82.7	>2400	>60.8	>64.7
12/5/01	42.43	21.8	1200	21.6	29.4
2/19/02	16.42	53.0	370	NR	NR
3/27/02	84.47	9.6	1700	44.6	50.2
4/25/02	71.30	11.6	>2400	>60.8	>64.7
5/14/02	78.09	10.6	520	NR	NR
6/12/02	6.96	79.5	>2400	>60.8	>64.7
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-3 Required Load Reduction for Arkansas Creek at ARKAN000.1WI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/10/01	0.46	87.1	>2400	>60.8	>64.7
11/29/01	129.20	0.8	>2400	>60.8	>64.7
12/18/01	20.98	9.4	980	4.0	13.6
1/22/02	12.09	17.7	580	NR	NR
2/26/02	9.86	21.5	1100	14.5	23.0
3/26/02	6.89	30.7	920	NR	7.9
4/8/02	51.71	3.0	110	NR	NR
5/6/02	13.11	15.9	520	NR	NR
6/25/02	6.88	30.7	>2400	>60.8	>64.7
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-4 Required Load Reduction for Murfrees Fork at MURFR003.9WI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/10/01	1.92	86.9	1700	44.6	50.2
11/29/01	872.7	0.4	2400	60.8	64.7
12/18/01	52.74	14.4	730	NR	NR
1/22/02	42.50	18.9	490	NR	NR
2/26/02	29.17	28.0	610	NR	NR
3/26/02	258.1	2.4	2400	60.8	64.7
4/8/02	24.19	33.6	870	NR	2.6
5/6/02	34.24	24.1	2000	53.0	57.7
6/25/02	1.95	86.6	1600	41.2	47.1
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-5 Required Load Reduction for West Harpeth River at WHARP017.7WI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/10/01	1.61	87.2	410	NR	NR
11/29/01	715.7	0.4	>2400	>60.8	>64.7
12/18/01	43.07	14.4	650	NR	NR
1/22/02	34.08	19.1	290	NR	NR
2/26/02	23.88	27.8	920	NR	7.9
3/26/02	207.9	2.5	>2400	>60.8	>64.7
4/8/02	18.86	34.4	820	NR	NR
5/6/02	27.10	24.6	1200	21.6	29.4
6/25/02	1.56	87.5	800	NR	NR
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-6 Required Load Reduction for Five Mile Creek at FIVEM001.4WI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/10/01	0.53	89.3	820	NR	NR
11/29/01	165.1	0.7	>2400	>60.8	>64.7
12/18/01	14.02	17.8	490	NR	NR
1/22/02	12.02	21.1	1700	44.6	50.2
2/26/02	5.24	42.7	730	NR	NR
3/26/02	25.47	9.4	1300	27.6	34.8
4/8/02	5.33	42.3	1300	27.6	34.8
5/6/02	16.29	15.3	2000	53.0	57.7
6/25/02	2.41	65.8	>2400	>60.8	>64.7
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-7 Required Load Reduction for Harpeth River at HARPE79.8WI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/10/01	24.93	84.1	170	NR	NR
11/29/01	2776.8	1.7	>2400	>60.8	>64.7
12/18/01	537.1	14.4	460	NR	NR
1/22/02	400.7	20.5	110	NR	NR
2/28/02	174.8	43.3	37	NR	NR
3/27/02	979.2	7.1	>2400	>60.8	>64.7
4/11/02	185.6	41.5	120	NR	NR
5/15/02	649.3	12.0	1700	44.6	50.2
6/4/02	85.99	63.6	160	NR	NR
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-8 Required Load Reduction for Kelley Creek at KELLE000.4RU

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/9/01	0.46	85.8	1600	41.2	47.1
11/8/01	1.06	74.6	>2400	>60.8	>64.7
12/12/01	9.81	17.1	210	NR	NR
1/29/02	9.59	17.6	160	NR	NR
2/21/02	5.47	31.8	150	NR	NR
3/18/02	69.25	1.9	>2400	>60.8	>64.7
4/10/02	4.32	38.9	25	NR	NR
5/23/02	5.58	31.3	920	NR	7.9
6/11/02	1.15	73.5	440	NR	NR
90th Percentile Concentration			**>2400**	**60.8**	**64.7**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-9 Required Load Reduction for Little Harpeth River at LHARP001.0WI

Sample Date	Flow	PDFE	E. Coli Sample Concentration	Required Reduction	
				Sample to Target (941 CFU/100 ml)	Sample to Target - MOS (847 CFU/100 ml)
	[cfs]	[%]	[CFU/100 ml]	[%]	[%]
10/18/01	20.22	57.3	130	NR	NR
11/20/01	8.36	77.8	83	NR	NR
12/13/01	172.54	7.2	1100	14.5	23.0
1/23/02	284.65	3.7	>2400	>60.8	>64.7
2/28/02	30.92	43.1	10	NR	NR
4/11/02	30.86	43.2	110	NR	NR
5/15/02	100.35	13.7	980	4.0	13.6
6/4/02	13.64	68.0	170	NR	NR
90th Percentile Concentration			**1490**	**36.8**	**43.2**

Notes: 1. NR = No reduction required.
2. 30-day Geometric Mean could not be calculated due to insufficient data.
3. Reductions for individual samples (shaded area) is included for reference only.

Table C-10 TMDLs, WLAs, & LAs for Harpeth River Watershed

HUC-12 Subwatershed (05130204__) or Drainage Area	Impaired Waterbody Name	Impaired Waterbody ID	TMDL	WLAs				LAs	
				WWTFs [a]		CAFOs	MS4s [d]	Precipitation Induced Nonpoint Sources	Other Direct Sources [e]
				Monthly Avg.	Daily Max.				
			[% Red.]	[CFU/day]	[CFU/day]	[CFU/day]	[% Red.]	[% Red.]	[CFU/day]
0101	Kelley Creek	TN05130204018 – 0400	>60.8	8.584×10^{7}	6.411×10^{8}	0	>64.7	>64.7	0
0105	Five Mile Creek	TN05130204016 – 1100	>60.8	5.742×10^{10} [b]	4.288×10^{11} [b]	0	>64.7	>64.7	0
	Harpeth River	TN05130204016 – 2000							
0201	West Harpeth River	TN05130204013 – 2000	>60.8	NA	NA	0	>64.7	>64.7	0
0202	W. Prong Murfrees Fork	TN05130204013 – 0730	>60.8	NA	NA	0	>64.7	>64.7	0
	Murfrees Fork	TN05130204013 – 0750							
0302	Little Harpeth River	TN05130204021 - 1000	36.8	NA	NA	0	43.2	43.2	0
DA	Trace Creek	TN05130204001 – 0600	>60.8	2.385×10^{9} [c]	1.781×10^{10} [c]	0	>64.7	>64.7	0
DA	Arkansas Creek	TN05130204010 - 0600	>60.8	NA	NA	0	>64.7	>64.7	0
0601	Jones Creek	TN05130204002 – 2000	>60.8	1.431×10^{10}	1.069×10^{11}	0	>64.7	>64.7	0
DA (in 0604)	Jones Creek	TN05130204002 – 2000	>60.8	NA	NA	0	>64.7	>64.7	0

Notes: NA = Not Applicable.

a. Future WWTFs must meet instream water quality standards at the point of discharge as specified in their NPDES permit.

b. The WLA listed is for the subwatershed and is equal to the sum of the WLAs for the individual facilities. WLAs for individual WWTFs corresponds to existing E. coli permit limits at facility design flow.

c. The WLAs listed apply to NPDES permitted discharges from WWTFs only. Pathogen loading due to collection system failure is considered to be unpermitted point source loading from the municipal WWTF. With respect to pathogen loading from leaking collection systems, a WLA of zero is assigned. It is recognized, however, that a WLA of 0 CFU/day may not be practical. For these unpermitted sources, the WLA is interpreted to mean a reduction in pathogen loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

d. Applies to any MS4 discharge loading in the subwatershed.

e. The objective for all "other direct sources" is a load allocation of zero. It is recognized, however, that for leaking septic systems a LA of 0 CFU/day may not be practical. For these sources, the LA is interpreted to mean a reduction in pathogen loading to the maximum extent practicable, consistent with the requirement that these sources not contribute to a violation of the water quality standard for E. coli.

APPENDIX D

Hydrodynamic Modeling Methodology

HYDRODYNAMIC MODELING METHOD

D.1 Model Selection

The Loading Simulation Program C++ (LSPC) was selected for flow simulation of pathogen-impaired waters in the subwatersheds of the Harpeth River Watershed. LSPC is a watershed model capable of performing flow routing through stream reaches. LSPC is a dynamic watershed model based on the Hydrologic Simulation Program - Fortran (HSPF)

D.2 Model Set Up

The Harpeth River Watershed was delineated into subwatersheds in order to facilitate model hydrologic calibration. Boundaries were constructed so that subwatershed “pour points” coincided with HUC-12 delineations, 303(d)-listed waterbodies, and water quality monitoring stations. Watershed delineation was based on the NHD stream coverage and Digital Elevation Model (DEM) data. This discretization facilitates simulation of daily flows at water quality monitoring stations.

Several computer-based tools were utilized to generate input data for the LSPC model. The Watershed Characterization System (WCS), a geographic information system (GIS) tool, was used to display, analyze, and compile available information to support hydrology model simulations for selected subwatersheds. This information includes land use categories, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

An important factor influencing model results is the precipitation data contained in the meteorological data files used in these simulations. Weather data from multiple meteorological stations were available for the time period from January 1970 through August 2004. Meteorological data for a selected 11-year period were used for all simulations. The first year of this period was used for model stabilization with simulation data from the subsequent 10-year period (10/1/94 – 9/30/04) used for TMDL analysis.

D.3 Model Calibration

Hydrologic calibration of the watershed model involves comparison of simulated streamflow to historic streamflow data from U. S. Geological Survey (USGS) stream gaging stations for the same period of time. A USGS continuous record station located near the Harpeth River Watershed with a sufficiently long and recent historical record was selected as the basis of the hydrology calibration. The USGS station was selected based on similarity of drainage area, Level IV ecoregion, land use, and topography. The calibration involved comparison of simulated and observed hydrographs until statistical stream volumes and flows were within acceptable ranges as reported in the literature (Lumb, et al., 1994).

Initial values for hydrologic variables were taken from an EPA developed default data set. During the calibration process, model parameters were adjusted within reasonable constraints until acceptable agreement was achieved between simulated and observed streamflow. Model parameters adjusted include: evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, recession, losses to the deep groundwater system, and interflow discharge.

The results of the hydrologic calibration for Harpeth River at Belleview, USGS Station 03433500, are shown in Table D-1 and Figures D-1 and D-2.

Table D-1. Hydrologic Calibration Summary: Harpeth River at Belleview(USGS 03433500)

			403.0947356
Simulation Name:	USGS03433500	**Simulation Period:**	
		Watershed Area (ac):	258063.21
Period for Flow Analysis			
Begin Date:	**10/01/90**	**Baseflow PERCENTILE:**	2.5
End Date:	**09/30/00**	*Usually 1%-5%*	
Total Simulated In-stream Flow:	**201.91**	Total Observed In-stream Flow:	**218.23**
Total of highest 10% flows:	**104.42**	Total of Observed highest 10% flows:	**112.49**
Total of lowest 50% flows:	**16.36**	Total of Observed Lowest 50% flows:	**15.89**
Simulated Summer Flow Volume (months 7-9):	**13.82**	Observed Summer Flow Volume (7-9):	**11.36**
Simulated Fall Flow Volume (months 10-12):	**50.52**	Observed Fall Flow Volume (10-12):	**45.88**
Simulated Winter Flow Volume (months 1-3):	**83.18**	Observed Winter Flow Volume (1-3):	**107.60**
Simulated Spring Flow Volume (months 4-6):	**54.38**	Observed Spring Flow Volume (4-6):	**53.40**
Total Simulated Storm Volume:	**197.60**	Total Observed Storm Volume:	**213.54**
Simulated Summer Storm Volume (7-9):	**12.77**	Observed Summer Storm Volume (7-9):	**10.18**
Errors (Simulated-Observed)		*Recommended Criteria*	Last run
Error in total volume:	**-7.48**	10	
Error in 50% lowest flows:	**2.97**	10	
Error in 10% highest flows:	**-7.17**	15	
Seasonal volume error - Summer:	**21.74**	30	
Seasonal volume error - Fall:	**10.12**	30	
Seasonal volume error - Winter:	**-22.69**	30	
Seasonal volume error - Spring:	**1.83**	30	
Error in storm volumes:	**-7.46**	20	
Error in summer storm volumes:	**25.37**	50	

Criteria for Median Monthly Flow Comparisons	
Lower Bound (Percentile):	25
Upper Bound (Percentile):	75

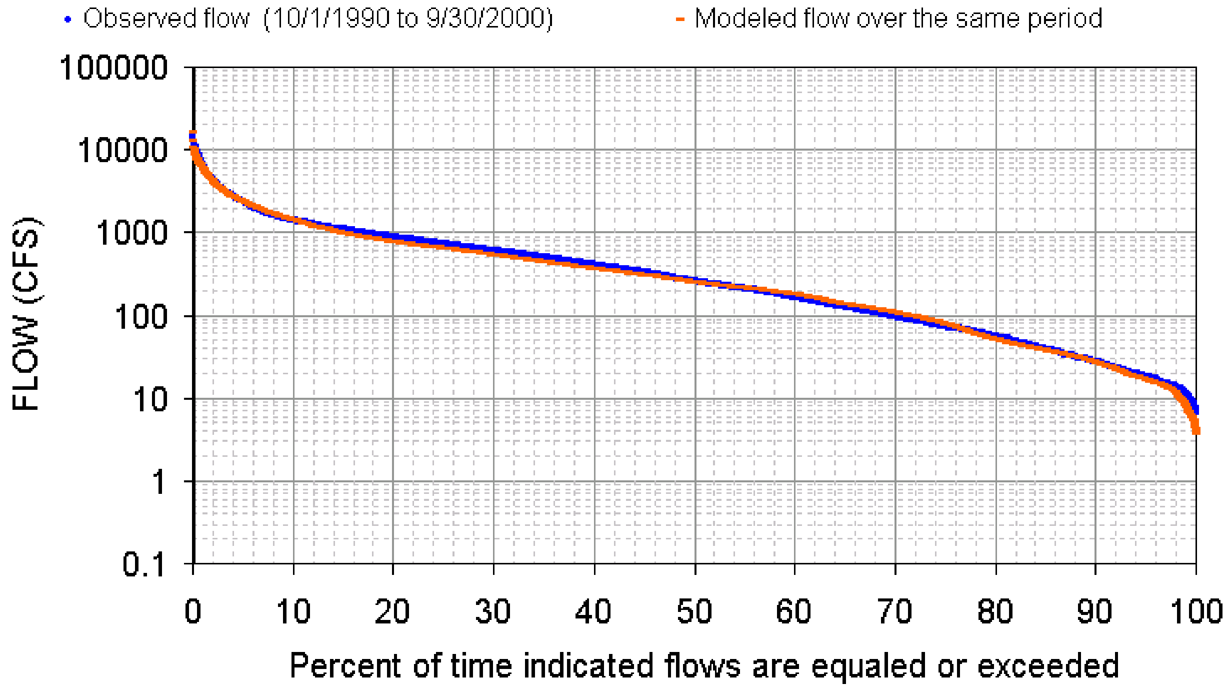

Figure D-1. Hydrologic Calibration: Harpeth River, USGS 03433500 (WYs1990-2000)

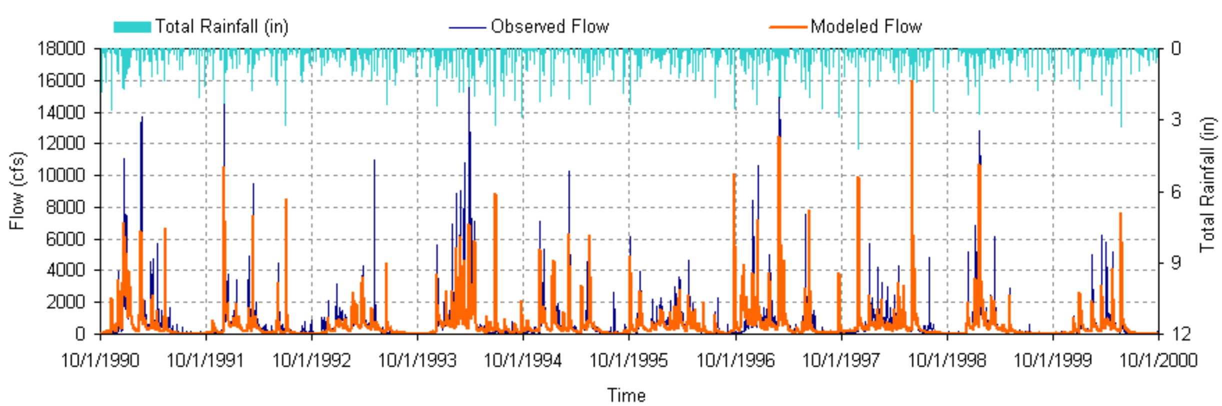

Figure D-2. 10-Year Hydrologic Comparison: Harpeth River at Belleview, USGS 03433500

APPENDIX E

Public Notice Announcement

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL

PUBLIC NOTICE OF AVAILABILITY OF PROPOSED TOTAL MAXIMUM DAILY LOAD (TMDL) FOR PATHOGENS IN HARPETH RIVER WATERSHED (HUC 05130204), TENNESSEE

Announcement is hereby given of the availability of Tennessee's proposed Total Maximum Daily Load (TMDL) for pathogens in the Harpeth River watershed, located in middle Tennessee. Section 303(d) of the Clean Water Act requires states to develop TMDLs for waters on their impaired waters list. TMDLs must determine the allowable pollutant load that the water can assimilate, allocate that load among the various point and nonpoint sources, include a margin of safety, and address seasonality.

A number of waterbodies in the Harpeth River watershed are listed on Tennessee's Final 2004 303(d) list as not supporting designated use classifications due, in part, to discharge of pathogens from pasture land and livestock in stream and discharge from MS4 areas. The TMDL utilizes Tennessee's general water quality criteria, continuous flow data from a USGS discharge monitoring station located in proximity to the watershed, site specific water quality monitoring data, a calibrated hydrologic model, load duration curves, and an appropriate Margin of Safety (MOS) to establish allowable loadings of pathogens which will result in the reduced in-stream concentrations and attainment of water quality standards. The TMDL requires reductions of pathogen loading on the order of 64-95% in the listed waterbodies.

The proposed Harpeth River pathogen TMDL may be downloaded from the Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding this TMDL should be directed to the following members of the Division of Water Pollution Control staff:

Vicki S. Steed, P.E., Watershed Management Section
Telephone: 615-532-0707

Sherry H. Wang, Ph.D., Watershed Management Section
Telephone: 615-532-0656

Persons wishing to comment on the proposed TMDLs are invited to submit their comments in writing no later than December 12, 2005 to:

Division of Water Pollution Control
Watershed Management Section
7th Floor, L & C Annex
401 Church Street
Nashville, TN 37243-1534

All comments received prior to that date will be considered when revising the TMDL for final submittal to the U.S. Environmental Protection Agency.

The TMDL and supporting information are on file at the Division of Water Pollution Control, 6th Floor, L & C Annex, 401 Church Street, Nashville, Tennessee. They may be inspected during normal office hours. Copies of the information on file are available on request.

APPENDIX F

Public Notice Comments Received

CITY OF FRANKLIN
TENNESSEE

David Parker
Director

*"Providing Innovation for the Future
While Maintaining a Connection to the Past."*

Engineering Department

RECEIVED
DEC 13 2005

December 9, 2005

Ms. Sherry H. Wang, Ph.D., Manager
Watershed Management Section
Tennessee Department of Environment and Conservation
Division of Water Pollution Control
7th Floor, L&C Annex
401 Church Street
Nashville, Tennessee 37243-1534

Re: **Comments on Proposed Total Maximum Daily Load (TMDL)
For Pathogens in the Harpeth River**

Dear Dr. Wang:

The City of Franklin engaged the services of our consultant for Stormwater Management Master Planning (CDM) to review and comment on the proposed Total Maximum Daily Load (TMDL) for Pathogens for the Harpeth River that you provided to us in November. Attached for your review and consideration are the comments provided by CDM and we ask that these comments be considered as our; City of Franklin; comments. We welcome the opportunity to meet with TDEC staff to discuss these comments and answer any questions you may have.

Sincerely,

David Parker, P.E.
Director of Engineering

C: Jay R. Johnson, City Administrator
Randy Wetmore, Assistant City Administrator
Chris Provost, CDM

109 3RD AVENUE SOUTH P.O. BOX 305 FRANKLIN, TENNESSEE 37065-0305
(615) 791-3218 TELEPHONE (615) 791-3293 FAX

CDM

Parkview Towers
210 25th Avenue North, Suite 1102
Nashville, TN 37203
tel: 615 320-3161
fax: 615 320-6560

December 6, 2005

Mr. David Parker, P.E.
Director of Engineering
City of Franklin, Tennessee
109 Third Avenue South
Franklin, Tennessee 37065

Subject: Proposed Total Maximum Daily Load (TMDL) For Pathogens in the Harpeth River

Dear Mr. Parker:

This letter is in response to your request and authorization to review the draft TMDL for Pathogens in the Harpeth River proposed by the Tennessee Department of Environment and Conservation (TDEC) on October 26, 2005. The deadline for comments to the state on this document is December 12, 2005.

The following observations are made from our review of the TMDL.

TMDL Approach

The establishment of TMDLs is based on a limited amount of E. coli and fecal coliform monitoring data. With respect to the City of Franklin, the stations of interest are:

- HARPE092.4WI – Harpeth River off Rivergate Drive, under I-65, upstream of Franklin
- FIVEM001.4WI – Five Mile Creek, at Old Peytonsville Road. Five Mile Creek discharges to Harpeth River upstream of Franklin.
- HARPE079.8WI – Harpeth River, at Cotton Road, downstream of Franklin but upstream of the confluence with West Harpeth River

Monthly samples from October 2001 through June 2002 were collected at these stations, for a total of 9 samples per station.

Pathogen monitoring data were used in conjunction with streamflow data to calculate pathogen loads associated with each sample. In most cases, flows were not actually measured at the monitoring station, and the flows represent modeled flows that were

CDM

developed using the Loading Simulation Program C++ (LSPC), a dynamic watershed model based on the EPA model HSPF (Hydrologic Simulation Program – FORTRAN). The modeled flow rate was then multiplied by the pathogen concentration to calculate the pathogen load on the sampling day.

In addition, flow modeling results for a ten-year period (October 1994 – September 2004) were used to determine a flow frequency-exceedance relationship at each station (i.e., for a given flow rate, what fraction of the time is that flow exceeded in the long-term). This information was used to plot the pathogen load data on a graph that showed the calculated load on the sampling day (point value) and the allowable load data (continuous curve) over the range of flow exceedance probability (0 – 100% probability of exceeded the streamflow). Figure 17 on page 35 of the draft TMDL report is an example of a plot for E. coli at station HARPE079.8WI.

The measured concentrations and calculated loads were compared to allowable concentrations and loads, which were calculated based on the streamflow and the allowable pathogen concentration. In this case, the allowable pathogen concentrations were set at 900 counts/100 ml for fecal coliform and 847 counts for E. coli. These values are 90% of the maximum allowable concentrations based on the State water quality standards, and this represents the "margin of safety" associated with this TMDL.

Comparisons are presented in tables (e.g., Tables C-11 and C-12 on page C-21 for station HARPE079.8WI) that provide information on each sampling date. The information includes modeled streamflow, streamflow percentile (based on 10-year frequency-exceedance curve for modeled flows), sample concentration and required reduction (i.e., percent reduction required to meet the concentration target, which is 90% of the maximum allowable concentration). Summary at the end of the table lists the 90th percentile pathogen concentration based on 9 samples, and the required reduction (again, the percent reduction required for the 90th percentile value to meet the concentration target).

The 90th percentile "required reduction" values from the comparison tables are the basis for the TMDL as presented in Table 9 on page 27 of the draft report. In general, the allocation is defined as a percent reduction, except for areas that have wastewater treatment facilities (WWTFs). The TMDL for WWTFs is a numeric value which presumably reflects the required percent removal and current allowable pathogen loads.

For Five Mile Creek and Harpeth River, Table 9 lists a required reduction of 87.1% for Subwatershed 05130204-0105 (see Figure 4 on page 11 of the draft report). The 87.1%

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David Parker
December 6, 2005
Page 3

value is based on the 90th percentile "required reduction" for fecal coliform at the Five Mile Creek station. The implication is that all sources of pathogens in that subwatershed (including the City of Franklin) need to reduce pathogen loads by 87.1%.

Evaluation of TMDL Analysis

Three major concerns were identified in the review. These include the following:

- Data limitations
- Data analysis and presentation
- Exclusion of pertinent data

Each of these topics is discussed below.

Data Limitations

One of the concerns identified is the limited set of data used in the analysis. To begin with land use (which is used to model flows and therefore loadings) is based on satellite imagery more than 12 years old. As you are aware, development in the Harpeth River Watershed has been extensive since that time. Digital forms of more recent land use data are available through the City and Williamson County; however these data were not accessed for the analysis.

In addition the water quality data used for the analysis is limited, and therefore could result in inaccurate conclusions. Using only nine samples as the basis for determining a 90th percentile concentration could be compared to developing a 10-year return period design storm with 9 years of rainfall data. At a minimum, it would be appropriate to have three or more years of monthly data (36 or more samples) to make a reasonable estimate of the geometric mean and 90th percentile pathogen concentrations. For example, the South Carolina Department of Health and Environmental Control (SCDHEC) analyzes 36 monthly samples to evaluate compliance with fecal coliform bacteria standards in shellfish waters.

Another issue is that the limited data do not appear to be representative of long-term conditions. For example, Tables C-11 and C-12 (station HARPE079.8WI downstream of Franklin) show that 3 of the 9 samples were taken on days for which the streamflow was in the top 10th percentile. In other words, 33% of the samples are characteristic of flow conditions that are expected to occur only 10% of the time, and therefore not representative of typical conditions.

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Data Analysis and Presentation

The question about representative data is particularly critical for station HARPE079.8WI, because the maximum concentration targets for fecal coliform and E. coli are exceeded only for the 3 samples with high streamflow conditions. Based strictly on the monitoring data, one could draw the conclusion that the target concentration is not attained for flows in the 0th to 10th percentile range, and is attained for remaining flows in the 10th through 100th percentile range. By definition, this would mean that the target concentration is not exceeded more than 10% of the time, and that therefore the pathogen concentrations at that station are adequately meeting the standards.

It should be noted that the load duration curves and required load reduction tables appear to be inconsistent. The load data plotted in the load duration curves do not appear to be plotted correctly. For example, Figure 17 on page 35 of the draft report shows two data points in the 0th to 10th percentile ("high flow") whereas Table C-11 on page C-21 of the report shows three data points in the 0th to 10th percentile range. This inconsistency occurs for all of the stations.

Exclusion of Pertinent Data

Though raw data are presented for station HARPE092.4WI in Table B-1 on page B-2 of the draft report, these data were not used to generate load duration graphs or required load reduction tables. This is a significant issue, considering that approximately 80% of the tributary area to station HARPE079.8WI is upstream of station HARPE092.4WI.

A quick analysis of the raw data for station HARPE092.4WI in Table B-1 indicates the following:

- This station also exceeds the maximum pathogen target concentration only for the 3 samples taken when the streamflow was in the 0th – 10th percentile range ("high flows")
- The 90th percentile value for fecal coliform is 6,720 counts/100 ml.

Based on the methodology as applied by TDEC, the required pathogen load reduction would be 86.6% for the tributary area to station HARPE092.4WI, which includes four subwatersheds (05130204-0104, 0103, 0102 and 0101).

Again, using the methodology that was used by TDEC, one could estimate the required pathogen load reduction as follows:

CDM

- Subwatersheds 05130204-0104, 0103, 0102, 0101 (80% of tributary area to station HARPE079.8WI): 86.6% (based on data for station HARPE092.4WI)

- Part of subwatershed 05130204-0105 tributary to Five Mile Creek station (5% of tributary area to station HARPE079.8WI): 87.1% (see Table C-9)

- Rest of subwatershed 05130204-0105 (including City of Franklin) (15% of tributary area to station HARPE079.8WI): 0%

- All five subwatersheds (100% of tributary area to station HARPE079.8WI): would achieve 73.6% reduction based on values shown above – required reduction is 72.6% (see Table C-11).

The "achieved" reduction of 73.6% is calculated as the sum of the products of load reduction and percentage of total tributary area (e.g., 86.6% * 80% + 87.1% * 5% + 0% * 15% = 73.6%). The calculations assume that the per-acre load of bacteria is the same in the three subareas (there is no way to know based on data in the report). The calculations also depend upon the estimation of the relative percentage of total tributary area that is in each of the three subareas (these areas were not measured and could be refined).

Consequently, the limited monitoring data suggest that reductions in pathogen loads in subwatersheds 05130204-0104, 0103, 0102 and 0101, and the part of 0105 that is tributary to the Five Mile Creek station may be sufficient for compliance with pathogen water quality standards at station HARPE079.8WI, without any load reduction in the rest of subwatershed 05130204-0105 (which includes the City of Franklin).

Summary

The proposed TMDL for pathogens in the Harpeth River suggests that an 87% reduction in pathogen loads is required in subwatershed 05130204-0105, in which the City of Franklin is located. Review of the TMDL methodology and available data identifies several weaknesses in the analysis, which include the following:

- Limited pathogen monitoring data, with an uncharacteristically high percentage of samples taken during high-flow conditions

- Exclusion of data for pathogen loads and concentrations coming from upstream subwatersheds 05130204-0104, 0103, 0102 and 0101.

CDM

When these factors are considered, it appears that adequate control of pathogen loads and concentrations in the upstream subwatersheds and in the Five Mile Creek tributary area would be sufficient to meet pathogen water quality standards at the Harpeth River station downstream of the City of Franklin, without any additional controls on the City of Franklin.

The implementation plan requires Franklin (as the holder of a Phase II stormwater permit) to submit an in stream monitoring plan to demonstrate effectiveness of BMPs to reduce pathogens. Although a monitoring plan can be developed, it may be difficult to demonstrate any significant reduction with watersheds upstream of Franklin contributing the loads documented in this TMDL.

CDM appreciates the opportunity to support the City in reviewing this TMDL. If you have any questions regarding our analysis or comments please do not hesitate to contact me. Remember that the City has until December 12, 2005 to submit any comments to TDEC.

Sincerely,

CAMP DRESSER & McKEE INC.

Christopher A. Provost, P.E.
Vice President

cc: Mark S. Hilty, CDM

File: 14915-46817-TMDL

APPENDIX G

Response to Public Comments

TDEC commends the City of Franklin and their consultant for their thorough review of the draft TMDL for Pathogens in the Harpeth River Watershed. The comments expressed by Mr. Provost demonstrate a clear understanding of the process involved in developing a TMDL. The following responses correspond to bulleted concerns presented by the City of Franklin and their consultant (see Appendix F, page F-5).

- Data limitations

  TDEC is aware that development in the Harpeth River watershed has been extensive in the past twelve years. We were not aware that digital forms of more recent land use data were available through the City of Franklin and Williamson County. A copy of this more recent land use has been requested. Land use data is most useful in determining sources of impairment and appropriate locations for application of BMPs. More recent land use data will not impact the required load reduction values.

  TMDLs are developed using the water quality data currently available. TDEC agrees that the existing data may not be representative of long-term conditions. As stated in Section 9.4 of the TMDL, additional monitoring and assessment activities are recommended for all impaired waterbodies in the Harpeth River watershed. No sampling events have occurred during the summer and few sampling events have occurred during dry periods and periods of low flow. Once additional monitoring representin all seasons and a full range of flow and meteorological conditions has been obtained, the required load reductions may be revised.

- Data analysis and presentation

  The load duration curves and required load reduction tables were inconsistent. The flow and PDFE values in the tables were corrected to match the load duration curves.

- Exclusion of pertinent data

  This pathogen TMDL was developed for those waterbodies within the Harpeth River watershed identified on the Final 2004 303(d) list as not supporting designated uses due to E. coli. Segment TN05130204016-2000 of the Harpeth River was assessed as impaired by E. coli. However, no water quality data was available from sampling locations within the impaired segment. Segment TN05130204016-1000 and a portion of segment TN05130204016-3000 are located in the same HUC-12 as segment TN05130204016-2000. Data for monitoring stations located on segments –1000 and –3000 were presented because TMDL analyses are performed primarily on a HUC-12 basis. HARPE079.8WI is located on segment TN05130204016-1000, which is downstream of the impaired segment, while HARPE092.4WI is located on segment TN05130204016-3000, which is upstream of the impaired segment. Neither segment is included on the Final 2004 303(d) List, although examination of the available data suggests both segments may be assessed as impaired during the next assessment cycle.

  Analysis was performed at station HARPE079.8WI because its drainage area includes the impaired segment and because it is closest to the “pour point” of the HUC-12. Analysis at station HARPE092.4WI would not include the impaired segment in its drainage area. As noted in the comments from the City of Franklin, analysis at HARPE092.4WI results in a load reduction of 86.6% as opposed to 72.6% at HARPE079.8WI.

The conclusion that "adequate control of pathogen loads and concentrations in the upstream subwatersheds and in the Five Mile Creek tributary area would be sufficient to meet pathogen water quality standards at the Harpeth River station downstream of the City of Franklin without any additional controls on the City of Franklin" may be correct. It is, however, based on certain assumptions (the per-acre load of bacteria is the same in the three subareas and the estimation of the relative percentage of total tributary area in each of the three subareas is correct), which may or may not be correct. One method of verifying the accuracy of this conclusion would be to provide additional water quality monitoring data.

The city of Franklin, Tennessee, has been issued coverage under the General Permit for Small Municipal Separate Storm Sewer Systems, permit number TNS075311. Williamson County, Tennessee, has also been issued coverage as permit number TNS0075795. The following are excerpts from the general permit:

3. SPECIAL CONDITIONS

3.1 Discharges to Water Quality Impaired Waters

3.1.1 Applicability: You must:

3.1.1.1 ***Determine whether storm water discharge from any part of the MS4 significantly contributes directly or indirectly to a 303(d) listed (i.e., impaired) waterbody.*** Water quality impaired waters means any segment of surface waters that has been identified by the division as failing to support classified uses**.** ***If you have discharges meeting these criteria, you must comply with Part 3.1.1.2 and 3.1.2*****;** if you do not, the remainder of this Part 3.1 does not apply to you.

3.1.1.2 ***If you have "303(d)" discharges described above, you must also determine whether a Total Maximum Daily Load (TMDL) has been developed by the division and approved by EPA for the listed waterbody.*** If there is a TMDL, you must comply with both Parts 3.1.2 and3.1.3; if no TMDL has been approved, ***Part 3.1.3 does not apply until a TMDL has been approved***.

3.1.2 Water Quality Controls for Discharges to Impaired Waterbodies. The storm water management program review submitted to the division must include a section describing how your program will control the discharge of the pollutants of concern.. This section must identify the measures and BMPs that will collectively control the discharge of the pollutants of concern. The measures should be presented in order of priority with respect to controlling the pollutants of concern.

3.1.3 ***Consistency with Total Maximum Daily Load (TMDL). If a TMDL has been approved for any waterbody into which you discharge, you must follow the procedure below and report on these activities in annual reports to the division:***

3.1.3.1 Determine whether the approved TMDL is for a pollutant likely to be found in storm water discharges from your MS4.

3.1.3.2 ***Determine whether the TMDL includes a pollutant wasteload allocation (WLA), implementation recommendations, or other performance requirements specifically for storm water discharges from your MS4.***

3.1.3.3 Determine whether the TMDL addresses a flow regime likely to occur during periods of storm water discharge.

3.1.3.4 ***After the determinations above have been made and if it is found that your MS4 must implement specific provisions of the TMDL, evaluate whether the implementation of existing storm water control measures is meeting the TMDL provisions, or if additional control measures are necessary.***

3.1.3.5 Document all control measures currently being implemented or planned to be implemented. Include a schedule of implementation for all planned controls. ***Provide your rationale (e.g., calculations, assessments, reports and/or other evidence) that shows that you will comply with the TMDL provisions.*** For control measures that are expected to be implemented and evaluated beyond the term of this permit, you should also include longer schedule of implementation as necessary to describe the control measure.

3.1.3.6 ***Describe a method to evaluate whether the storm water controls are adequate to meet the requirements of the TMDL.***

3.1.3.7 If the evaluation shows that additional or modified controls are necessary, describe the type and schedule for the control additions/revisions.

Note, in particular, the bolded, italicized portions of the above excerpts. Section 3.1.3.2 specifically addresses TMDL implementation recommendations and Section 3.1.3.6 requires a method to evaluate whether storm water controls are adequate to meet the requirements of the TMDL. The fundamental requirement of the TMDL is improvement of water quality such that Harpeth River supports its designated use classifications. Effluent or in-stream monitoring is the only method for documenting improvement in water quality and attainment of water quality standards.